THE

DIARIAN MISCELLANY:

CONSISTING OF

All the Ufeful and Entertaining Parts, both Mathe-
matical and Poetical, extracted from the

LADIES' DIARY,

From the beginning of that work in the year 1704,
down to the end of the year 1773.

With many additional

SOLUTIONS and IMPROVEMENTS.

In five Volumes.

VOL. I.

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LONDON:

Printed for G. Robinson and R. Baldwin in Pater-
nofter Row, 1775.

P R E F A C E.

THE late ingenious Mr. Thomas Simpson, who was one of the worthy compilers of the original Ladies' Diary, speaking of the merit of that little book, says " that for upwards of half a century, this small performance, sent abroad in the poor dress of an almanac (and that under a title, not calculated to raise the highest expectations) has contributed more to the study and improvement of the mathematics, than half the books professedly written on the subject. The most celebrated authors now among us, have contributed to promote the reputation of the Ladies' Diary; and the compiler thinks he may, without any offence to truth, venture to pronounce, that the mathematical part (at least) is, at this time, greatly superior to every attempt to imitate it, and not below the notice of the best judges."

On this head I shall not enlarge, as the merit of this little annual performance is too well known and acknowledged, to need any more particular declarations of it in this place. I shall therefore only employ a few lines, by way of preface, in pointing out the motive for this publication of the diaries collected, with the plan on which it has been completed.

The extreme scarcity of the more early numbers of the diary, with the importance of the many curious particulars of which the whole consists, had rendered a collection of the whole almost invaluable. And as it had long been found almost impossible to collect together any number of complete sets of them, it was therefore earnestly desired that, from some one entire collection of them, a republication might be made of the most useful and entertaining parts extracted from the whole. In consequence, several attempts were at different times made, by some spirited friends of the work, to collect a complete set, and to furnish the public with an edition of such extracts. Unluckily

a 2   however,

however, from various caufes, their attempts gene-
rally failed on being carried into execution. Among
the reft, the editor of this collection, with much
trouble at laft completed an entire fet, with the fame
laudable view; and by the kind affiftance of fome
friends, and the generous encouragement of the pub-
lic, he has been enabled to bring out this edition of
the fo long defired work, from the beginning of it in
the year 1704 to the end of the year 1773, including
a period of 70 years.

Being aware of the difficulties attending the proper
execution of this bufinefs, both with regard to the na-
tural abftrufenefs and intricacy of many parts of the
work, and to the afcertaining of the beft plan and me-
thod of conducting it; before I began to print any part
of the book, I collected together all the affiftance, in
both refpects, from many ingenious and learned gen-
tlemen, who were well acquainted with the nature of
the work, by whom I was fupplied with feveral other
corrected folutions, and from all their opinions con-
cerning the plan or manner of printing, &c. I have
been enabled to extract one which feemed to be the
leaft exceptionable of any, and according to it the
work has been at length completed. Of that plan I
fhall now give a fhort account.

Agreeably to the wifhes of moft people, the grand
out-line refolved on was, a republication of all or moft
part of the ufeful and entertaining articles of the
work, viz. all the mathematical parts, and almoft all
the poetical or enigmatical ones. In two volumes
therefore I have included thefe laft-mentioned parts;
having omitted only fome fmall things of leaft value,
as rebuffes and paradoxes, with fome few of the lefs
elegant folutions of the enigmas where they were cum-
berfomly numerous. And in three volumes are in-
cluded all the mathematics, both queftions, folutions,
tracts, and eclipfes. And here folutions have been
carefully fupplied where they were wanted, the erro-
neous ones corrected, and the obfcure ones explained
and elucidated; alfo to the annual calculations of
eclipfes are added accounts of the obfervations made
of

of the fame eclipfes collected from various publications,
which it was thought might be of ufe in fhewing the
degree of nearnefs in the tables from which the calcula-
tions had been made, when the computers were fuch as
might be depended on : all which additions are printed
in a fmaller type by way of notes at the bottoms of the
pages; fo that the text or work itfelf is regularly dif-
pofed without any interruption from them. All the
parts are printed after the order of their dates ; by
which difpofition it very readily appears what each
year's original diary confifted of, and from which it
might again be eafily recompofed and thrown into its
original form. The running titles at the tops of the
pages are fo contrived as to fhew both the particular
fubject there treated on, the year's diary to which it be-
longs, the number of years it is from the beginning of
the work, and the author or compiler of the work for
that year. From thefe titles it appears that the 70
years include a fucceffion of five different authors, viz.
Mr. John Tipper, the original projector and beginner
of the work, from the year 1704 to 1713 inclufive ;
Mr. Henry Beighton from 1714 to 1744; Cap. Rob.
Heath from 1745 to 1753 ; Mr. Tho. Simpfon from
1754 to 1760; and laftly Mr. Edw. Rollinfon from
1761 till his death in 1773. Thefe are all the nominal
authors that have conducted the work during the dif-
ferent years of its exiftence : but befides them there
were fome other perfons who have been at different
times partly concerned with them in its management;
fo it is faid that for fome years before the death of Mr.
Beighton, the mathematical parts were compofed by
his friend Mr. Ant. Thacker, as being a better mathe-
matician ; and that for fome time before and after his
death, the enigmatical parts were managed by his
amiable wife.

Of all thefe perfonages I had thought to have given
here a fhort hiftory, as a proper appendage to this
complete edition of a work in which they defervedly
acquired fo much honour ; but after many fruitlefs
endeavours to procure proper materials for fuch me-
moirs, I have been at laft obliged to relinquifh that
favourite

favourite defign for want of fufficient papers relating to the lives of the more early compilers.

It may be perhaps not unneceffary to obferve that, in a few fheets near the beginning of this work, the original orthography and other peculiarities of language are retained, where they appeared to have proceeded from defign; but that in the reft of the work throughout, the obfolete fpelling and grammatical inaccuracies are moftly altered agreeably to the prefent ftate of our language; and the propofing of a queftion in bad verfe, has, in one or two inftances which feemed to require it, been turned into plain profe.

Finally, at the end of the laft volume of poetry is added a lift of the fubjects of all the enigmas in chronological order. And at the end of the laft volume of mathematics, an alphabetical lift of all the diary writers, with the queftions fubjoined which each propofed and anfwered; as alfo, an appendix, containing additional improved folutions to fome few of the queftions, with corrections of the material errors which had efcaped notice in the printing, and which might affect the fenfe of the reading. Other fmaller inaccuracies are, by the editor, fubmitted to the indulgence of the candid reader.

THE

MATHEMATICAL PARTS

OF THE

LADIES' DIARIES.

1705

Of the Motions of the Sun and Moon.

THERE is is nothing more ftrange and fuprifing to fome perfons, than the various motions and appearances of the fun and moon. To fee, for inftance, the fun rife fometimes due eaft, and fet due weft, at other times to fee him rife and fet a great way more northward, and at half a year after a great way more fouth. To obferve the days to increafe one time in the year a whole hour in 15 days, and at another time not above 10 minutes in the fame fpace of time, and fometimes to ftand at a ftay. Likewife to fee the moon fometimes to rife and fet not above a quarter of an hour's diftance from her rifing or fetting the precedent night, and at another time fhe will be an hour and an half diftance of time from her rifing or fetting the precedent night. To fee her fometimes full, at other times gibbofe, after that horned, then again wholly to difappear, fometimes to be eclipfed in part, at other times totally eclipfed: Thefe appearances are very ftrange and unaccountable to moft people; but to give my fair reader fome infight into thefe myfteries, I fhall endeavour to explain the motions of thefe two great lamps of heaven, and that by an inftrument very familiar to the female fex; I mean by the rim of an ordinary fpinning-wheel.

Suppofe then the outward or larger circle in the following figure, to be the farther fide or edge of the wheel's rim; the inward or leaft circle, the hither edge thereof: Suppofe the middle circle to be a line drawn round the middle of it, or elfe

elfe if you pleafe the wheelftring tied clofe quite round the middle of the rim: and tho' thefe three circles are in the figure one bigger than another, becaufe it could not be drawn otherwife upon paper, yet you muft imagine them all equal, and that this is the upper or outfide of the rim. (As for the pricked circle we fhall confider that prefently.)

Now let us fuppofe a fly was in the middle and top of the rim at (*a*,) and it run with a regular and even motion towards (*b, c, d, e, f,*) and fo on till it run quite round the rim, in juft the fpace of a minute. Now if while, at the fame time, the fly at (*a*) begins its motion towards (*b, c, d,* &c.) you turn the wheel about the contrary way juft four times in a minute, namely, towards (*b, g, f, &c.*) as you do in fpinning. It then plainly follows, that the fly will go about once whilft the wheel runs the other way four times, fo that when the rim is turned once about, the fly will be advanced one quarter of the rim and be at (*d,*) when the rim has been turned twice about, the fly will be half way at (*e,*) when thrice fhe will be at (*f,*) when four times they meet again exactly at (*a*).

Again, if when the fly began to move at (*a*) and go to the left-hand, you began at the fame time to move the wheel-rim towards the right-hand or contrary way? And inftead of turning it about four times, you had turned it twelve times about in the fame time as the fly had gone about once. (It matters not whether it be in a minute, or hour, or day, or month, or any other time, provided it be the

fame time exactly, that the fly moves once about, the rim moves twelve times about the contrary way.) Upon this fuppofition, the fly, at the end of the firft turning about of the rim, will be advanced to (*b*), a twelfth part of the circumference; at the end of the fecond turning about, it would be advanced to (*c*), another twelfth part; at the end of the third revolution, the fly would be advanced to (*d*), a third twelfth part, or quarter of the circle; and fo likewife at the end of fix revolutions of the wheel, the fly would be advanced to (*e*), half way, and at the end of twelve returns it would come to (*a*) again; the fly conftantly and perpetually advancing in its flow motion one way, as the wheel did its fwifter motion the
other

other way. And the like you may conceive if the wheel made 30, 50, 100, 365, 500, or any other number of revolutions at the same time as the fly did one, it would neceſſarily fall out, that at the end of that reſpective number, the fly would come to its place again, from whence it firſt ſet out, and it matters not whether it began to move at (*a*), or at any other place at *b, c, e,* &c.

Let us once more ſuppoſe another wheelſtring ty'd about the rim of the wheel, the upper part at ♋ to touch the edge of the rim at the ſide next to you, the under part of the wheel-ſtring to touch the edge of the rim fartheſt from you at ♑, and then it would croſs the wheelſtring in the middle of the rim juſt half way between top and bottom on each ſide at (*d*) and (*f*,) (or which is all one at ♎ and ♈.) And now if you ſuppoſe the fly to begin to move about the ſecond wheelſtring, tied croſs-ways over the firſt repreſented by the prick'd circle from ♋ to ♌ ♍ ♎, and ſo round to ♋ again; and whilſt the fly moved once round, the wheel was turned the contrary way any number of times, (ſuppoſe 4 or 12 times) it would finiſh its revolutions juſt as is before declared, but with ſome difference to its former motion, as ſhall preſently appear.

Just thus is the motion of the ſun, moon, and planets in the heavens. For the ſun and ſtars go by a * proper motion of their own from weſt to eaſt, as did the fly; and the whole heavens with ſun, moon, and ſtars, are carried the contrary way as the hand turned about the wheel; the ſun moves ſo ſlow, that while he goes once about in his own courſe, along the prick'd line one way, the heavens are carried about 365 times the contrary way, and then he comes to the ſame place again: But the moon is ſwifter in her motion, and runs round from weſt to eaſt, whilſt the whole heavens is whirled about 27 times and a quarter, or (which is all one) in 27 days and a quarter.

But from this motion of the ſun round the prick'd circle, ariſes ſeveral appearances carefully to be obſerv'd, becauſe it ſhews the reaſon of many of thoſe particulars I at firſt men-tioned, viz. Let us ſuppoſe the ſun in ♋ going onward in his own ſlow motion towards ♌, and ſo on to ♍ ♎ ♏, &c. And the whole heavens carried about the contrary way once a day. It follows, that upon that day, which is about the †11th of June, he is neareſt over our heads, and maketh the longeſt

day

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* Our author is not here to be underſtood to mean an abſolute or real motion; he means only the apparent motion ariſing from the real motion of the earth.

† Our author having written before the change of the ſtyle, all his times muſt be underſtood according to the old ſtyle, and will require 11 days added to adapt them to the new.

day with us, and then he rifes and fets very much towards the north, and the line which he maketh in the heavens that day, is called the tropick of Cancer.

In a quarter of a year after, he will be got along the prick'd line to ♎, and then the days and nights are of equal length; and he rifes juft in the eaft and fets in the weft, and the line which he maketh in the very midft of heaven, is called the equinoctial circle, and this happens about the 12th of September, [and juft fo it will be half a year after when he comes to ♈, which will be about the 10th of March.]

In a quarter of a year after, he is at ♎, he will come down by degrees to ♑, and then he is fartheft from us, which happens about the 10th of December, and then the circle he feems to make in the heavens that day, is called the tropick of Capricorn, and then he rifes and fets very much towards the fouth.

The prick'd line, in which the fun is fuppofed to pafs, is called the ecliptick, becaufe there can be no eclipfe but the moon muft be in or very near this circle; but the fun never goes out of it.

The whole breadth between the outward and inward circles (which two muft be imagined equal) is called the zodiack, which is the only circle in the heavens that hath any breadth. The diftance of any ftar from the ecliptick or prick'd circle, is called the ftar's latitude, (either north or fouth as it happens be either north or fouth from the circle) and the diftance of any ftar from the middle circle or equinoctial, is called its declination, (north or fouth as before.)

Again, when the fun is near the tropicks, as when he moves from ♊ to ♌, he moves juft againft the motion of heavens, and fo is fwifteft in his motion, and makes a greater fpeed toward's his journey's end; but then the length of the day and declination (or diftance from the middle circle) is but little alter'd: But when he moves near the equinoctial, as from ♍ to ♏, then he runs obliquely or croffes the heaven, and then the days and declination increafe or decreafe evry confiderably, but he moves but flowly towards his journey's end, becaufe he croffes the heavens from one fide of the middle to the other; and this is one of the reafons why from noon to noon is not exactly 24 hours, but fometimes more and fometimes lefs.

As the fun thus runs in a circle of his own from weft to eaft, in one year, fo doth the moon in a circle of her own in 27 days and a quarter the fame way; and the moon's circle croffes the fun's circle in two points, juft as the fun's circle croffes the equinoctial in ♈ and ♎: But the diftance of the moon's circle, from the fun's, in the wideft place, is not quite a fourth part the diftance of the fun's circle from the equinoctial. But of this and of the various appearances of the moon, I have not now room to proceed.

AN

AN ECLIPSE of the fun is caufed by the moon, who is a dark body, being interpofed or placed between the fun and us, and this happens when the moon is near one of the points where her circle croffes the ecliptic or fun's circle. Thus, fuppofe the earth, whereon we live, to be in the middle of the prece-dent figure at $\ominus$, the fun at (f) and the moon at Υ. Here becaufe the moon at Υ interpofes, it takes away the light of the fun from us; fuch will be the pofition of the fun and moon upon May-day next year, 1706. It will begin to be darkened at 9 minutes after 8 in the morning, but at 17 minutes after 9 it will be the moft darkened, when near 10 parts of 12 of the fun's body will be obfcured, and he will appear like the firft appearances of the new moon. This will be a great eclipfe; we had a greater in 1654, but a much greater in the year 1652, when the whole body of the fun, within lefs than 16 minutes, was obfcured.

An eclipfe of the moon is caufed by the fun's being on one fide the earth, and the moon on the other, (near the ecliptick) and the fhadow of the earth falls upon the moon, (from whence fhe hath her light.) As fuppofe the fun in $\simeq$; the earth in $\ominus$, the moon in (f), here the light of the fun at $\simeq$, falling upon the earth at $\ominus$, takes away the light of the moon at (f), who otherwife would reflect her light back upon us as at other times.

There are a great many admirable conclufions to be drawn from the confideration of eclipfes, but more of that hereafter.

1706

Of the nature of an Eclipfe of the Sun, and of that great Eclipfe which will happen upon May-day this prefent year, with the exact time of its beginning, middle, and end; re-commended to the obfervation of the curious.

THE mind of man hath a ftrange propenfity, and eager thirft after knowledge; nor will he fpare for pains to gratifie his curiofity; he will traverfe mountains, valleys, woods and defarts; he will plunge thorough the vaft and raging ocean; he will penetrate into the bowels and caverns of the earth; nay, fome will not ftick to go to Hell beneath, to compafs know-

ledge

ledge. But of all the objects of our thoughts, there is none
more noble, or give a greater satisfaction to the mind, than
the contemplation of the heavenly phenomena, the motions,
periodical revolutions, appulses, and other passions and effects
of the fixed stars and planets. This made the poet cry out,

> Ye sacred muses ! with whose beauty fir'd,
> My soul is ravish'd, and my brain inspir'd;
> Give me the ways of wand'ring stars to know:
> The depth of heav'n above, and earth below?
> Why flowing tides prevail upon the main:
> And in what dark recefs they shrink again?
> What shakes the solid earth? what cause delays
> The summer nights, and shortens winter days?
> Teach me th' various labours of the moon,
> And whence proceed th' eclipfes of the sun ?

<div align="right">DRYDEN.</div>

Last year I gave you an account of the true motion of the
sun and moon about the heavens, with the various appearances
caused thereby, such as the increase and decrease of the days
and nights, of their rising and setting, and of their eclipses;
which things being rightly conceived, will be of great advan-
tage towards the easie apprehending the following discourse
of the eclipfe of the sun, which I now the rather undertake,
because there will be a very great eclipfe upon May-day next,
the like not having been these fifty years past.

Now an eclipfe of the sun is when the moon (who is a dark
opake body) interposes or happens to come between the sun
and us, and shades or hides the light of the sun from us, and
this is sometimes wholly, and then it is called a total eclipfe;
and sometimes but in part, and then it is called a partile eclipfe.

To conceive aright the true nature of the sun's eclipfe, you
may provide or imagine a large hoop of two yards diameter
or widest breadth, cut off a third part from the rest, and nail
to the middle of this piece a stick of just a yard in length, that
it may be like a crofs bow without a string, and as you see in
the lower part of figure 1. where f, g, c, h, i, reprefents the
bow or third part of the hoop, and K, c, the stick. Suppose
now you saw (or imagined you saw) a very fair rainbow
painted on the clouds (as is alfo in figure 1. the upper part)
take your hoop, and holding the end of the stick at K to your
eye, turn the hoop to the rainbow, and hold it fo that the
hoop may feem to cover the rainbow, and hide it from your
fight. Being thus fixed, turn the stick (to which the hoop is
fastened) a little, that the hoop may crofs, or feem to crofs, the
rainbow, the half f, g, c, being above it, and c, h, i, below it, as
you may fee in figure 2. where a, b, c, d, e, reprefents again
the rainbow, and f, g, c, h, i, the hoop, and $\ominus$ at K reprefents
the eye, (but here the stick affixed to the hoop is wanting.)

<div align="right">Now</div>

Now if you join, or suppose to join, the other part of the hoop to this, to compleat the circle, and if you imagine the rainbow to be compleatly round, and about 400 yards diſtance every way from your eye, this will repreſent to your fancy pretty near the true paths or circles wherein the ſun or moon move; and alſo the proportions that their diſtances bear to one another.

For 1. The place of your eye at *K*, in either figure, repreſents ⊖ the earth you ſtand on. 2. The hoop repreſents the circle or path the moon moves in, who compleats her whole round from weſt to eaſt in about *29 days and a half. (See the laſt year's Diary.) 3. The rainbow repreſents the path of the ſun, being likewiſe a vaſt circle encompaſſing both the earth and circle of the moon, but a great way beyond it every way, and he moves round his circle once in a year. 4. The circle of the moon is not juſt under that of the ſun, but croſſeth it, as you muſt ſuppoſe it to do in fig. 1. and as it plainly appears in fig. 2. This place of
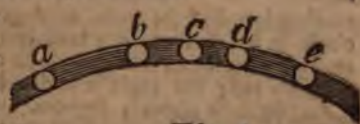
Fig. 1.

Fig 2.

Fig 3.

croſſing

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* This is the Synodical month, or time between one lunation and another, and is 2 days and a quarter longer than the periodical month mentioned in the laſt year, page 3; this exceſs is cauſed by the motion of the earth (and moon) almoſt a whole ſign during the time of the periodical month, and the moon muſt continue to revolve for this additional time to bring her to a conjunction again.

croffing is called the node, or dragon's head. Now had the circle in the figures been compleatly round, it would crofs again on the other fide, which is called the other node, or dragon's tail; the angle it makes at the croffing *f, c, a,* or *e, c, i,* fig. 2. is about 5 degrees.

Thefe things being rightly conceived, it follows:

1. If the circle of the moon had been juft under the circle of the fun, then at every conjunction, or new moon, there would be an eclipfe of the fun, (and at every oppofition, or full moon, there would be an eclipfe of the moon.)

2. But the circle of the moon croffing that of the fun, it follows there can be no eclipfe of the fun, but when the moon is in or near her nodes, or places of croffing, as you may plainly perceive by the figures. For fuppofe the moon in *f,* (in either fig.) the fun in *a,* and the eye at ⊖ (or *K,*) here the moon is above the fun, or higher than he, and therefore cannot hinder its light from us: if the moon had been at *i,* and the fun at *e,* the fame thing would happen, for then the moon is lower than the fun, and fo eclipfes him not: if the moon meets the fun when fhe is near her node, fuppofe at *g,* and the fun at *b,* here fhe paffeth but a little above him, and fo he efcapes an eclipfe. But if when the moon was at *h,* the fun was at *d,* here the moon would pafs between the fun and ⊖, and appear half eclipfed; but if the moon was in *e,* the very point where her circle croffes that of the fun, and fuppofe the fun at the fame time to be at *c* alfo, then would the fun be totally eclipfed.

From whence it is plain, that whenever there is a conjunction, (or meeting of the fun and moon, (if it comes within the bounds of an eclipfe) then earer the moon is to her node, the greater will be the eclipfe of the fun, and the farther fhe is from it, the fmaller will be the eclipfe; but when fhe is fo far from her node, or place where the circle croffes, that half the apparent breadth of the fun, and half the breadth of the moon will not reach to touch one another, then there will be no eclipfe for that conjunction; but if the conjunction be when the moon is a great way farther from her node, (as it moftly happens) then moft certainly there can be no eclipfe for that time.

Upon May-day next, the fun, 'tis true, will not be totally eclipfed, but the centers of the fun and moon will be but 5 minutes, very near, diftance afunder, and will be the greateft eclipfe that hath happened thefe 50 or 60 years in our ifland: the time of the beginning, middle, and end thereof, I will give you from the calculation of one of the greateft aftronomers of this, or perhaps of all former ages, as alfo the parts of the globe the fhadow will pafs over. (See fig. 3.)

The middle time of the eclipfe of the fun, that happens
May

May the firſt, 1706, will be in the meridian of London at 9 ho. 41 min. in the morning.*

The viſible beginning of the eclipſe at London at 8 ho. 23 min.

The end at 10 ho. 37 min. and an half. At 9 ho. 30 min. about the middle of the eclipſe, the diſtance of the centers of the ſun and moon will be 5 minutes very near, and ſo will be of almoſt 10 digits and an half from the ſouth.

The ſhadow begins to enter the diſcus of the whole earth almoſt in the mid way between the Heſperiden and Caribee iſlands, then tending into the eaſt, leaves the Canary iſlands upon the left, and paſſes through the kingdom of Morocco. Hence coaſting the eaſtern ſhore of almoſt all Spain, it reaches Provence in France, near the port of Thoulon. Whence the ſhadow paſſing forward, after being ſpread through Piemont, and the country of Milan, deſcribes the borders of Bavaria and Auſtria, and then paſſing over Bohemia and Sileſia, over-ſhadows almoſt half Poland and Lithuania. Hence being carried by the regions of Moſcovy and Siberia, it ſlips into un-known Tartary, and laſtly above China it quits the earth, the ſun being there totally obſcured in its ſetting. But where the centers of the ſun and moon fall in together, the darkneſs will be like that of night, and the ſtars will be viſible for the ſpace of the one four and twentieth part of an hour.

How to behold an eclipſe of the Sun without hurt to the eyes. *By* Mr Pond.

TAKE a burning glaſs, ſuch as men uſe to light tobacco with in the ſun; or a ſpectacle glaſs that is thick in the middle, ſuch as is for the eldeſt ſight, and hold this glaſs in the ſun as if you would burn through it a paſteboard, or white paper book, or ſuch-like: draw the glaſs from the board or book twice as far as you do to burn with it: ſo by direct hold-ing it nearer or farther, as you ſhall ſee beſt, you may behold upon your board, paper, or book, the round body of the ſun, and how the moon paſſeth between the glaſs and the ſun, du-ring the whole eclipſe.

This may'ſt thou practice before the time of an eclipſe, wherein thou ſhalt diſcern any cloud paſſing under the ſun; or by another putting or holding a bullet or his finger's end betwixt the ſun and the glaſs, at ſuch time (the ſun ſhining) as thou holdeſt the glaſs, as before thou art taught.

<div align="right">I ſhall</div>

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* Theſe times are a few minutes different from thoſe given by the author laſt year, page 5. The obſerved times I ſhall give afterwards along with the other eclipſes.

I fhall in my next give an account of the eclipfe of the moon, and of feveral admirable conclufions that are to be drawn from the confideration of the eclipfes of both the great luminaries.

1707

Of the Phafes and Eclipfes of the Moon.

HAVING in my laft given you an account of the nature of an eclipfe of the fun, as alfo of that great eclipfe on May-day, it was my intentions to have been very nice in the obfervation of it, by cafting its fpecies upon paper by a te- lefcope, and by fix concentric circles equidiftant from their center, to obferve the digits eclipfed from time to time, and. to have corrected the clock by calculation from the fun's alti- tude, and to have inferted my obfervations in this place; but the unfavourablenefs of the weather fpoiled all my defigns: however fometime thro' the clouds the eclipfe was perceived, and, as near as could be gheffed, at the very fame time, and in the fame appearance exactly as was there fet down. and as by the figure of it was reprefented; the fame fide being enlightened, and the fun appearing not much unlike a new moon of 3 or 4 days old; and this was all the obfervation I was. able to make.

I come now, according to my promife, to fpeak of the nature of an eclipfe of the moon, and of feveral obfervations and ufeful inferences, to be drawn from the eclipfes of the luminaries.

Now an eclipfe of the moon (as I have already fhewn in my Diary for 1705) is caufed by the earth's interpofing or hap- pening to be exactly in a right line between the fun and moon, by reafon whereof the light of the moon is obfcured by the fhadow of the earth.

To conceive this aright, if you imagine (or actually put) a lamp or candle on one fide of the room, (fuppofe five foot high from the floor;) and a looking-glafs on the other fide of the room, (five foot high alfo from the floor;) and if a fine thread was tied and ftretched out ftreight (or if you imagined' a right line extended) from the middle of the looking-glafs to the flame of the lamp, overthwart the room; then if you ftand in the middle of the room, half a yard (more or lefs) on either fide the extended thread, (or imaginary line) and looking towards the glafs, you may plainly fee the light of the lamp reflected back to your eye, (or to fpeak as the common people conceive it, you may fee the candle in the
                                                                glafs.)

b

glafs.) And the like will happen if you place your eye fome diftance either above or below the line.

But if you put your eye or head juft between the lamp and the glafs, (where the line or thread is) then will your eye or head caft a fhadow upon the glafs fo that it cannot reflect back the light, (or to fpeak with the vulgar, it will ftop the light fo that it cannot fhine on the glafs.) [And the fame appearances would happen if the eye remained fixed to the ftring in the middle, and the candle was lifted up and down.]

Not much unlike this is an eclipfe of the moon, for the moon hath no light of her own, but the fun fhining on her, fhe reflects back his light, as the glafs reflects back the light of the candle or lamp; but when the earth happens to come juft between, then it hinders the light of the fun from fhining upon the moon, or to fpeak more properly, the fhadow of the earth falls upon the moon and eclipfeth her.

But to make this as plain as poffible (and withal to account for the various phafes of the moon, why fhe appears round, gibbous, half-round, horned, and fometimes not at all :) Suppofe inftead of a plain looking-glafs you took a glafs globe, and having it filvered withinfide, to make it a globular looking-glafs. Place this, inftead of the other, oppofite to the lamp or candle: fuppofe then in figure 1. the fun (*S*) reprefented the lamp, and the little circle (*e*) reprefented the globe looking-glafs, and that your eye was placed fomewhere between both, fuppofe at (*m*.) Now looking towards (*e*,) (if the eye was either higher or lower, or on the one fide or other of the imaginary line between them) then would the light fall upon (*e*) and reflect back upon (*m*) and half the globe would be enlightened. But if the eye be exactly in the middle between them, then would the eye fhade the glafs (as in fig. 2.) and fo darken it. That is, it ftops the light from fhining on the glafs, and fo it cannot reflect any back. (Or as I faid before, if the eye and glafs remain fixed, and the light or lamp moved up and down, the fame appearances would enfue.) And juft after this manner, is an eclipfe of the moon : the fun being on one fide the earth (*S*) and the moon on the other (*e*): then if the earth doth not happen to be in the middle, as it for the moft part falls out, (the reafon whereof is fhewn at large in the laft year's Diary) then there is a full moon to us that live upon the earth, and no eclipfe ; but if the earth happen to be juft between them, as many times it doth, then there muft needs be an eclipfe of the moon (as in fig. 2.)

From the confideration of what hath been here faid, and viewing with fome attention the firft figure following, may the various phafes or appearances of the moon be eafily apprehended.

For the globe glafs at (*e*) being round the light at (*S*) cafts its beams, or fhines upon that half oppofite to it; for it muft needs fhine upon half, nor can it fhine either upon more or lefs than half, but always upon that half that is juft facing the light, the other half from the light being dark of confequence: I fay the light (*S*) cafting its beams upon (*e*) enlightens that half towards it, fo to the eye that is in (*m*) directly backwards, the whole half is reflected back, and appears perfectly round in the edges.

But if you order an affiftant to remove the lamp to (*f*), then part of the enlightened half to you at (*m*) is turned from you, and you can fee but three parts of it, and one quarter of the dark'ned part becomes turned towards you. If the light is removed to (*g*) and then but one half, if to (*h*) but one quarter, and if to (*a*) then none at all of the enlightened half to you at (*m*) is to be feen, it being from you; and if it was removed ftill on to (*b, c, d, e,*) the light would encreafe to the eye placed at (*m*) as it did decreafe before.
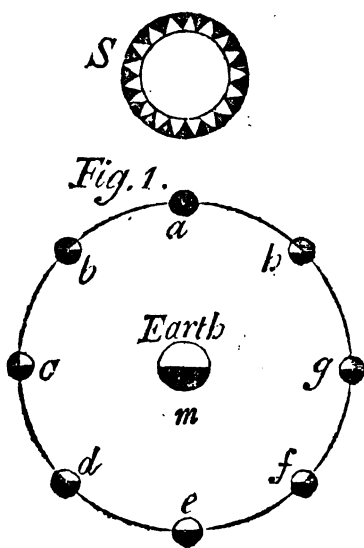
Fig. 1.
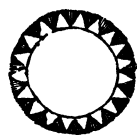
Fig. 2.

This being rightly conceived, if inftead of the imaginary *lamp* at (*S*) you conceive it to be the fun, and if for the globe-glafs

glafs at (e) you conceive it to be the moon, and for the eye at (m) you conceive it to be the earth you ftand on, the very fame appearances will happen, and confequently the reafon of the various appearances of the moon are, I hope, made very plain without any farther explication.

But to return from this digreffion to the eclipfe. If the earth's fhadow covers the moon but in part (more or lefs) it is called a partile Eclipfe, but if it cover it in the whole, it is called a total Eclipfe.

Such an Eclipfe will happen on the fixth day of April next, the beginning will be a little before midnight, and will continue till half an hour after three next morning, as followeth.

April the 6th, 1707.

		ho.	min.	
The beginning of the eclipfe will be at		11	40	at night.
Beginning of total darknefs	—	12	45	
The middle of the eclipfe	—	1	34	
End of total darknefs	— —	2	24	next morning.
End of the eclipfe	— —	3	29	
Total duration will be	— —	3	49	And thus much
Total darknefs will continue	—	1	39	of this eclipfe.

Obfervations on Eclipfes of both luminaries.

1. The fun is very feldom, but the moon often totally eclipfed, yet in the whole, the eclipfes of the fun are the more frequent of the two.

2. The beginning and end, and quantity eclipfed, of an eclipfe of the moon, is feen from all parts of the earth (where it is confpicuous) at the fame moment of time (altho' under diverfe meridians:) but in eclipfes of the fun it is not fo, being at the fame moment of time feen lefs in one place than another, and lafting in fome places fhorter, in others longer, and in fome none at all.

3. The beginning of an eclipfe of the fun is on the weftern part of his limb, which part is alfo firft reftored to light. But in an eclipfe of the moon, it begins and ends on the eaftern limb.

4. Total eclipfes of the moon are made fometimes in a longer time, at other times quickly: but total eclipfes of the fun are all without delay.

5. The moon in total eclipfes is fometimes quite loft, but at other times it fhines very plainly with a red colour, either in whole or in part.

The ufes of, or conclufions drawn from, Eclipfes.

1. The courfe of the moon would not truly be known without eclipfes, by reafon of her parallax.

C   2. The

2. The fun is both higher and greater than the moon.

3. The earth is greater than the moon, but lefs than the fun.

4. Both fun and moon are fpherical, unequally diftant from the earth.

5. The fun is the fountain of all light, but the moon is but a borrowed light from the fun.

6. From eclipfes are found the difference of meridians or longitude of places.

7. From eclipfes of the fun and moon, a reafon is found of meafuring their diftances from the earth, as alfo of the magnitude and proportion that the fun, moon, and earth have between themfelves; which otherwife may feem impoffible.

By thefe wings it is the mind of man flies up into the heavenly theatre, and by thefe charms (as the poet faith) draws down the fun and moon from heaven to earth.

1708.

Of the Ptolemaick Syftem of the Univerfe.

HAVING in my former Diaries explained the motions of the fun and moon, as alfo the nature of their eclipfes, with the reafon why the moon appears in fo many various fhapes in the fpace of one revolution; I come now to fpeak of the other five planets, viz. Saturn, Jupiter, Mars, Venus, and Mercury: but before I proceed it will not be amifs to explain the fyftem of the univerfe.

There are various opinions among the learned concerning this difficulty, but the moft prevailing are thefe two, namely, the Ptolemaick, and the Copernican, both which I fhall now explain.

Ptolemy, Ariftotle, and others held, that the earth is the center of the univerfe, which remains fixed and immoveable, and the whole heavens, and fixed ftars, move round her in this order. (See fig. 1. following)

The planet that moves in a circle or orbit, next above the earth, is the moon; next above her moves the planet Mercury; next above Mercury, at a greater diftance ftill from the earth, doth the planet Venus move; and ftill in a higher orb moves the glorious fun; the planet next above the fun is Mars; and Jupiter moves ftill in an orb or circle, extended every where beyond the orb of Mars: Laftly, the fartheft of the planets from the earth is Saturn, and he moves in a

larger

larger circle than them all. Above thefe planets, a vaſt diſtance, are the fixed ſtars, and above the fixed ſtars, is the primum mobile and emperial heaven.   And this is the Ptolemaick hypotheſis.

Of the Copernican Syſtem of the Univerſe.

THE Copernican ſyſtem makes the ſun to be the center of the univerſe, (as in the following fig.) round which (in the order there ſeen) are the orbits of Mercury, then that of Venus, then that of the earth, with that of the moon about it; then thoſe of Mars, Jupiter, and Saturn, one above another, and about the two laſt the ſmall circles, that their attendants or ſatellites march in, of which more anon; and above all theſe the fixed ſtars, &c.

This is the order of the heavens, according to Plato, Ariſtarchus, Archimedes, and other ancients; and after it had been almoſt quite forgot for many ages it was revived by Copernicus, and is now almoſt univerſally received.

However,

However, both thefe hypothefes do equally folve the doc-
trine of the fphere, the firft being the moft eafy for beginners,
but the latter the more rational.

But fince thefe hypothefes have been received in the world,
the later aftronomers have, by the help of the telefcope, found
out many furprizing appearances, which I fhall fet down more
particularly in the order as they lie in the heavens, beginning
with the uppermoft, and fo defcending down to our earth.

And firft for the fixed ftars: that whitifh band or zone,
that encompaffes the whole heavens, called the Milky-way,
and of which the ancients could give no tolerable account, is
found by the telefcope to be no other than an heap of very
fmall ftars, thickly fet together; which by their great dif-
tance, fmallnefs, and clofenefs, appear to the naked eye, as
one united whitifh cloud. In like manner the Pleiades, or
Seven Stars, tho' (faith my author Mr Molyneux) fcarce more
than fix appear, are found by an ordinary glafs, to be nigh
forty; and Dr Hooke, in his Micrographia, faith, that with
a twelve-foot telefcope he plainly difcovered 78 in the fame
afterifm, of no lefs than 14 feveral magnitudes, the biggeft
whereof

whereof is not accounted greater than one of the third magnitude. And in the single constellation of Orion, the telescope discovers more stars, than the naked eye can number, in all the heavens; and there is scarce any corner of the heavens so dark but the telescope being turned towards it, descries multitudes of glittering spangles therein. On this account the seed of Abraham, that was to be made numerous as the stars in the firmament, may yet (for ought we know) admit of propagation thro' many future generations, before it comes up to its limits.

From the fixed stars let us contract our prospect, and in a vast, long, and almost immense course homewards, we first meet with Saturn. By his slow motion he takes state upon him (being near 30 years in walking round the heavens) as carrying about him something more weighty than ordinary. But the short sight perceives nothing thereof, and sees nothing but a plain round globe, all his equipage and attendants are hid from our view, till survey'd more closely with the telescope, and then behold a mighty ring, parallel to the equator, bright as the planet's own face, encompassing round his body: but this is not all his equipage, for besides this throne of light, this majestick planet is constantly attended by a guard of five satellites or moons, that follow his motion, and dance round him continually in a circle.

Jupiter next presents himself, less encumbred than Saturn, yet not wanting a courtly train; for tho' his guards are but four in number, yet their size and brightness shew their strength, and their quick motion round him shews their diligence.

Galileo (who invented the telescope) was certainly the first inhabitant of this globe that ever saw them, and how strangely was he surprized, and struck with wonder, to see four little moons dancing round Jupiter, that from their first creation, to that lucky moment, had never struck the eye of any mortal inhabitant of this globe before. Were these then made for the use of poor man, from whose knowledge these were concealed for 5000 years together? Vain man! that thus presumest to confine the designs of the Almighty to miserable dust and ashes, when his infinite power can make millions of intelligent beings, to serve and praise him.

Besides these four little moons about Jupiter, the telescope discovers that there are about his body several brighter and darker parts like broad belts or zones, almost parallel to the ecliptic; as also a spot found in him, by which 'tis manifest that Jupiter turns round his own axis in the space of about 10 hours. A very strong argument to prove that our earth may do so likewise, since Jupiter who is so considerably bigger than the earth, has a motion much more quick than ours in 24 hours. He moves about the heavens in about 12 years.

Mars offers himfelf next, who trufting in his own ftrength is attended by no guards; he compleats his circle in 687 days; but the prying telefcope difcovers in his face, fcars, fpots, and ruggednefs, by which the ingenious Caffini has determined, that he turns on his own axis, once in about 24 hours and three quarters. But however furious his beams are, he is beholden for them to the great fountain of light, and heat, the fun, which is plainly vifible, in that, when he is in his quadratures with the fun, and in his perigæon, he may be feen almoft bifected, and to increafe and decreafe in light as our moon (but never fo much as to be horned as the other inferiors.)

The glorious Sun doth next prefent itfelf, in whofe bright face we can hardly expect to find dark fpots; yet fuch there are, and frequent too.

Scheinerus has publifh'd a large book in folio, of nothing elfe: the only difcovery that has been made by thefe fpots, is, that the fun turns round about his own axis in the fpace of 25 days and a quarter. Formerly one fhould feldom fee the fun's face (no more than now our brighter beauties here below) free from one or more black patches, but now (as if they were grown out of fafhion) he feldom wears any, one in five or feven years hardly appearing; as if now he put them on, more of neceffity to cover an odd pimple, that may otherwife disfigure his countenance, than to adorn his face: how far the fair fex fhould follow his example, I dare not venture to determine; but from them we naturally fall to Venus.

Venus, the brighteft planet in the heavens, fhe fears not fometimes, even at noon-day, to difplay her beauty, and in this armour repofing an entire confidence, performs her courfe alone, and free from all other attendants, in 225 days.

Mercury's wit and quicknefs fecures him; therefore he has no train, but generally fhelters himfelf under the beams of his potent lord, the fun, and performs his circuit round him in about 88 days. But both thefe inferior planets are found by the telefcope to increafe and decreafe as our moon; for fometimes they appear horned, fometimes half enlighten'd, fometimes gibbous, and fometimes full, even on, or nigh this conjunction with the fun: by which it is manifeft, the Ptolemaick hypothefis is falfe, whatever hypothefis is true.

And thus at laft are we arrived at home to contemplate our neighbour the Moon, which we may call our own; for as the fatellites about Saturn and Jupiter move about them, fo moves the moon as a fatellite about us. By the telefcope we diftinguifh in the moon's countenance, an admirable difference of parts, both for fhape and colour; the greater parts refembling our feas, lakes, rivers, iflands, peninfulas, and continents; the leffer fpots refembling mountains, hills, and valleys: but whether the moon is inhabited or not ftill admits

mits of various difputes, tho' believed by the moft ingenious fo to be.

1709

Of the Nature and Motion of Comets.

COMETS, or blazing ftars, were by the ancients taken to be nothing elfe but vapours and exhalations, or fuch-like diffipable matter: But by our late aftronomers (and that more truly) they are found to be a fpecies of planets, that revolve about the fun in eliptical orbits, whofe periodical times and motions, are as conftant, certain, and regular, as thofe of the planets. The eliptical orbits are fo very oblong and excentrical, that they are but little different from para-bola's, and may be confidered at fuch.

Alfo the inclination of the plains of the planets, are at moft not above five or fix degrees different from the plain of the ecliptick, yet the plains of comets are exceeding various, and are at all imaginable angles of inclination with one ano-ther, and with that of the ecliptick.

Likewife the courfe of comets in the orbits is not deter-mined one way, (as is that of the planets from weft to eaft) but indifferently; fome of them move one way and fome ano-ther: for fometimes they move from eaft to weft; fometimes from weft to eaft; fometimes from north to fouth; other times from fouth to north; and fometimes obliquely between any of thefe ways, according as the fituation of the plains of their orbits, and the direction of their courfes together do determine.

It is obferved, that comets in their defcent to, and afcent from the fun, pafs quite through the planetary fyftem, as by the enfuing figure may plainly appear; which effectually con-futes the notion of folid orbs, which fome of the ancients fo fondly conceited.

Some comets approach in their perihelia, fo very near the fun, that they muft be prodigioufly heated thereby, and this to fuch a degree, that they may not be intirely cold for many years. Thus the laft famous comet in 1680 and 1681, at its perihelion on the eighth day of December 1680, fufteined a degree of heat twenty eight thoufand times as great as that we feel with us in fummer; or about two thoufand times as intenfe as is that of a red hot iron. So that by Sir Ifaac Newton's calculation, if that comet was as big as our earth, as denfe

denſe and ſolid as iron, and were throughout equally heated
to the forementioned degree, 'twould ſcarce, in our air, be
fully cooled in fifty thouſand years: ſo that it cannot conſiſt
of vapours and exhalations as the ancients thought.

*The ſolar ſyſtem, with the manner of a comet's departure
from, and deſcending towards the Sun.*
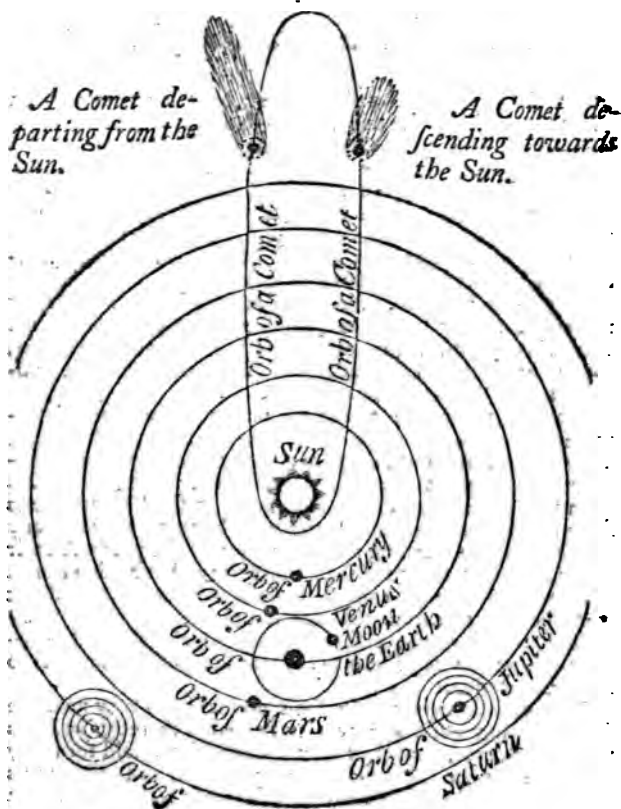
The ingenious Captain Hally faith, that the comet which appeared in 1682, will probably appear again, in 1758, being 50 years yet to come. But by a careful review of the hiftory of comets, I have, with no fmall pains, endeavoured to find out the times of the revolutions of feveral of them: and if the hiftories I have perufed are true, there will be feveral appearances of them, before that time; nay, I am almoft per-fwaded

That one (or more) comet or blazing ftar, is now near at hand, or fome ftrange appearance in the heavens.*

1710

Of the Fixed Stars.

HAVING in my former Diaries, given an account of the fun, moon, and other planets; of the various fyftems of the heavens, of the wonderful difcoveries made by the telefcope, of the fyftems of the comets, and of the paffions and affections of the wandring ftars, I come now to treat of the fixed ftars, and of their various magnitudes, diftances, number, and conftellations.

All thofe glittering ftars (except feven) which we fee befpangling the firmament of heaven, and encircling the terreftrial orb at unmeafurable diftances, are called fixed ftars; for tho' they feem to roll about the earth in four and twenty hours, yet they keep the fame diftances from one another, and from the ecliptick, they rife and fet upon the fame points of the horizon, and pafs the meridian at the fame altitude, and are as if they were fo many lucid points fixed to the ce-
leftial

* The above difcourfe and prediction of our author feems to have had very fufficient grounds for a foundation; for, when he had perceived from *Doctor Hally's Aftronomia Cometica Synopfis*, or otherwife, that at leaft fourteen comets had been obferved in different years throughout the preceding century, he needed no witchcraft to affert that *feveral* would appear during the next 50 years; and accordingly many comets appeared during that time (as we fhall remark in their refpective years as they occur in courfe), and among the reft Doctor Hally's anfwered very well according to his prediction. Our author however does not feem to have had the pleafure of obferving the accomplifhment of his prediction, as he died in 1713 or 1714, and I find no accounts of any more comets before the year 1717.

leſtial firmament, for which reaſon they are called the fixed
ſtars.

The number of them which appear to the naked eye, ac-
cording to the ancient aſtronomers, are 1022. But ſince the
teleſcope hath been invented, they are found to be innumerable.

Their diſtances from us are incredible, being according
to the computation of our modern aſtronomers, ſo far off,
that if from one of the biggeſt ſtars, (which are ſuppoſed to
be the neareſt) a bullet was ſhot out of a cannon, and to con-
tinue its utmoſt ſwiftneſs till it arrived at our earth, it would
be little leſs than ſeven hundred thouſand years in its jour-
ney, before it could reach us.

Their magnitudes are no leſs amazing, for according to
Gallileus (whoſe account is much leſs than ſome others) the
body of the leaſt ſtar is above nine hundred thouſand millions
of times bigger than the globe of the earth.

But to wave at preſent theſe nice ſpeculations, and to come
to particulars more obvious and certain: Let us ſuppoſe our-
ſelves in an open plain, in a curious clear and charming night,
viewing the beſpangled heavens, and beholding the wondrous
works of the Almighty; we cannot but obſerve ſtars of dif-
ferent bigneſs, and of different luſtre and glory. To diſtin-
guiſh theſe from one another, the ancients divided them into
ſix degrees of bigneſs or magnitude: thoſe that you ſee the
biggeſt and brighteſt of the whole firmament, they called
ſtars of the firſt magnitude; thoſe that you ſee of the next
inferior bigneſs and brightneſs, they called ſtars of the ſecond
magnitude; thoſe of the next degree, ſtars of the third mag-
nitude; and ſo they gradually decreaſed to the ſixth magni-
tude, which are the ſmalleſt ſtars of all: now to many of the
moſt eminent ſtars, the ancients gave particular names, call-
ing one Aldebaran, another Regulus, a third Rigel, a fourth
Arcturus, a fifth Procyon, a ſixth Dubbe, and ſo of many
others of divers magnitudes, giving names to about fifty ſtars
in all.

To have deviſed names thus for every ſtar, would have
been very troubleſome, if not impoſſible; to remedy this in-
convenience therefore, they ſeparated the ſtars into divers
parcels, ſome more and ſome leſs; and formed them by their
imagination, into the ſhapes of men, women, birds, beaſts,
and the like; which ſerved them to as good purpoſe, as if the
appearance of thoſe ſhapes were viſible in the heavens; for
by theſe images or imaginary creatures, they came to know
and name the ſtars, as diſtinctly, as if they were called by
particular names; and after they came to be more accurate
in aſtronomical obſervations, they put down upon paper, the
true bearing, diſtance, and magnitude of the ſtars, and actu-
ally drew about them the ſhapes as they before imagin'd
them

them in the heavens: and thus they parcelled out all the visible stars into * 48 constellations or parcels, 12 whereof were in the middle of the heavens, encompassing it about like a girdle, which they called the 12 signs, (in which the 7 planets always move) 21 constellations or images they parcelled out towards the north part of the heavens, and 15 towards the south, to which the modern astronomers have added 12 more in the southern hemisphere, unseen by us.

But that my fair reader may the better apprehend my meaning, I shall descend to some particulars. Not far from the north pole, the ancients parcelled out 35 stars, whereof 7 are of the second magnitude, 3 of the third, 8 of the fourth, 12 of the fifth, and 5 of the sixth magnitude, and formed about them the shape of a bear, and called this constellation by the name of the Great Bear, (to distinguish it from another constellation of 10 stars, lying near these, called the Little Bear) which being put down upon paper, in their true and proportionate distances and magnitudes, as they are in the heavens, with the image drawn about it, will appear as in the figure *marked on the celestial globe.*

From which figure the stars in the heavens may be easily known, and distinguished, the one from the other.

Thus there is the star at the end of the tail of the great bear, the star in the middle of its tail, and the star in his rump, which has a distinct name given it, viz. Alioth, (as also hath that star in his back called Dubbe); the lower star in his hinder foot, and the star in his mouth or under jaw; and so of the rest, according to the places or parts of his body wherein they are posited.

But these seven more eminent stars (all of the second magnitude) are by seamen separated from the rest, and made a constellation by themselves, called the Wain or Charles's Wain, whereof the two lower stars are the two wheels, the two stars above these are the waggon part, and the other three stars the three horses (or oxen) to draw it; whereof one is the thill-horse (or the filler) called Alioth, the middle-horse, and
the

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* The number of constellations now in use are 77, viz. the 12 signs or constellations of the zodiac, 28 constellations on the north of it, and 37 on the south. Many stragling or unformed stars having been reduced into constellations by modern astronomers.

The number of stars also now put upon the constellations are more in number than those mentioned by our author in this discourse, as I shall shew at the end of it.

In perusing the descriptions of these constellations, the reader ought to have at hand a celestial globe; and comparing each constellation and star there with its description here, will impress a very just idea of its form, situation, &c.

the fore-horfe of the wain. The image, picture, or fhape of this wain, you may eafily form in your own imagination.

The fartheft two ftars from the end of the tail of the great bear are by our feamen called the guards; for by them they find the ftar at the end of the tail of the little bear, called the pole ftar: Thus, if you look upon thefe two ftars in the heavens, and extend a line in your imagination from the one to the other, and fo continue it in the heavens about five times the diftance of thofe two ftars, you will meet with the pole ftar of the fecond magnitude; or the end of the tail of the little bear (of mighty import to the feamen) or by fome called the fore-horfe of the little wain, from whence you will eafily find the 7 ftars of the little wain, being in the fame fhape as the greater wain. [But the ancients added 3 ftars more to thefe 7, and formed the conftellation into the fhape of a little bear, as I faid before.

A little behind the tail of the great bear, are another parcel of ftars, which the ancients drew into the image of a man, and called this conftellation Bootes, or the driver of Charles's wain. He is alfo called Arctophylax, the keeper of the bear. There is another ftar in the border of his garment, of the firft magnitude, feveral times mentioned (with other ftars and conftellations) in the holy fcriptures, namely, Job. 9. 9. Job 38. 32. and in Amos 5. 8. It is called Arcturus, which in the hebrew fignifies a congregation or gathering together, fuitable to the expreffion in Job 38. 32. Canft thou guide Arcturus with his fons? that is, with all the other ftars that make up that conftellation.

Any of the ftars of this conftellation may be known as in the laft; for I fhould fay, the ftar between his hook and his head; that in his cheek; that in his girdle; the lowermoft in his leg; the middlemoft in his knee; the uppermoft between Arcturus and that in his knee, &c. you can eafily point them out, and know them as diftinctly as if each of them had a particular name.

Another company of ftars that encompafs the pole of the ecliptick, and lie difperfed in various places, the ancients formed into an image or conftellation called the Dragon, wreathing and twifting itfelf betwixt the two bears: It is a notable conftellation, having ftars in every one of the 12 figns, and the pole of the ecliptick is in the very middle of it. It hath one ftar of the fecond magnitude, being the laft but two in the tail. Another ftar is called Rafaben, being a bright ftar in the head of the dragon, famous for that the ingenious Mr Robert Hooke, Fellow of the Royal Society, made ufe of this ftar, to attempt the proof of the motion of the earth by obfervation, in 1674. Where he obferved (as the Reverend Mr Flamfteed hath diverfe times fince) a parallax of the

the earth's annual orb, which infallibly proves the motion of the earth to be true, according to the doctrine of Copernicus.* To give one instance more:

Behind the neck of the dragon, the ancients formed another constellation of stars into the image of a swan. The star near the tail is of the second magnitude, and is called aridef or arided; and near the star in its breast a new star appeared in the year 1601, and after some time disappeared. In the year 1658 it appeared again, and likewise in the year 1670, and so it continued appearing and disappearing several times; it was a star of the third magnitude, and at this time wholly disappears.

The stars in this (as in the other constellations) are easily known and distinguished, if you observe about what parts of the head, neck, breast, wings, tail, &c. they are placed. What their magnitudes are, &c.

And thus you see the method made use of by the ancients, to distinguish and name the greatest part of the visible stars in the firmament, by forming most of them into images and constellations.

There are some few of the lesser stars, which could not conveniently be brought into constellations, which they called informes, or unformed stars, such as the six small stars beneath the great bear; and the three stars before its head; the two small stars by the tail of the dragon, and divers others: yet these are also easily known by their situation, distance from, or neighbourhood to the constellations near which they are placed, or to some parts of them.

I am persuaded that nothing can be more diverting to the fair sex, than to be able to know and name the constellations and stars in the firmament, and to point them out to her fair companions in a serene clear night; saying, (for instance) "Look yonder, madam, that great star of the first magnitude, " is called the bull's eye, that cluster of little stars near it is " in the bull's neck, and called the pleiades; that star of the " second magnitude, is the end of his north horn; and that " of the third magnitude is the tip of his south horn. Look " yonder is the great warrior Orion. This constellation is " men-

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* Unfortunately for our author, and the great astronomers whose authorities he quotes, the change of place of the fixed stars hath been discovered since by *Doctor Bradley*, to be owing to other causes, viz. the aberration of the rays of light and the libration of the earth's axis. The parallax of the earth's orbit not amounting to one second, and is quite imperceptible to all instruments.

But this mistake does not however invalidate the *Copernican* motion of the earth, that being sufficiently proved by other means.

" mentioned, with the pleiades and others, in the book of
" Job, cap. 38. Thofe three ftars of the fecond magnitude,
" is called his girdle; and that ftar of the firft magnitude,
" on this fide it, is in his left fhoulder; and that great ftar of
" the firft magnitude, beyond his girdle, is in his right
" foot, and is called rigel; thofe three fmall ftars in a right
" line, are in his fword. Look yonder, farther fouthward, in
" a ftreight line with Orion's girdle, is the moft glittering
" ftar in the heavens, called firius; this ftar, with 18 others,
" make up a conftellation called the great dog; this firius
" being in his mouth, and that other towards the right hand
" is in his left foot, &c." The knowledge of thefe particu-
lars, I prefume, will be very entertaining to the ladies, all
which I fhall endeavour to fhew in fome of the fucceeding
Diaries.

1711

Of the Conftellations of the Zodiack.

IN my laft year's diary, I began my difcourfe of the fixed
ftars; and therein fhewed you, how the ancients (the
better to know them) feparated them into divers parcels,
called conftellations; giving to fome of them the names of
men and women, as Cepheus, Orion, Caffiopea, &c. to others
the names of beafts, birds, fifhes, &c. as the lion, the bull,
the eagle, the whale, &c. to others the names of inanimate
beings; as the altar, the fhip, the balance, &c. And the better
to give my fair reader a juft notion or idea of thefe conftella-
tions, I there fhewed you, that there were 48 of thefe images
or conftellations reckoned among the ancients; namely, 12
in the middle of the heavens, 21 on the north fide, and 15 on
the fouth fide the fame; all which I defigned only as an in-
troduction to the knowledge of the fixed ftars. I fhall now
proceed to inftruct my reader, not only in the knowledge of
the names and fhapes of the conftellations, but alfo how to
find them in the heavens, and to point out the moft noted
ftars in the firmament.

I fhall begin with the 12 images, that environ the whole
heavens in the middle like a girdle or zone; for which reafon
they are called the 12 figns of the zodiack; and becaufe they
are fo often mentioned, and come frequently into ufe (more
efpecially becaufe the feven planets, or wandering ftars, con-
ftantly move therein.) The ancients invented 12 characters

or

or marks to reprefent them; not made at all adventures, but
neatly contrived to know them thereby, and which are made
ufe of at this day.

Thefe 12 images, conftellations, or figns, are placed in the
heavens in this order: Aries, Taurus, Gemini, Cancer, Leo,
Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius,
Pifces, and are placed in the heaven from weft towards the
eaft, or (with us) from the right hand towards the left.

Thus, if I fee Aries in the heavens, the next fign Taurus,
ftands towards the left hand, or eafterly of Aries, and the
next fign Gemini, ftands more eafterly, or on the left hand
(to us) of Taurus, and fo of all the reft.

The firft conftellation, or fign in the zodiack, is called
Aries, or the Ram; and the character or mark the ancients
made ufe of to know it, was two horns fet upright, thus, ♈.
This fign confifts of nineteen fmall ftars, whereof that called
the firft ftar of Aries is the moft remarkable, becaufe from it
many aftronomical tables were formerly calculated; and from
this ftar Copernicus accompted the proceffion of the equi-
noctial. About four hundred and feventy years before our
Saviour's time, this ftar was in the firft fcruple of Aries; but
it is now in 29 degrees and 4 minutes of the fame fign; and
about 1780 it will entirely leave Aries, and be got into the
fign Taurus. There is alfo the bright ftar on the top of his
head, the ftar in the rump, &c. as I fhewed you more fully
in my laft. (Over the ram is a fmall conftellation of three
ftars called the triangle, which I have here alfo remarked
the better to find out Aries by.)

The next conftellation of the zodiack is Taurus, the Bull,
denoted by the ancients with a horned head of a bull,
thus ♉. This image confifts of 48 ftars, whereof one is
of the firft magnitude, called his fouth eye; it is alfo
called by the Arabians, aldebaran. Another in the tip
of his north horn is of the fecond magnitude, that
of the third magnitude is the ftar at the end of his
fouth horn, then the ftar in the bend of his knee, &c. In
this greater conftellation, are included two fmaller, one of
five ftars in his forehead, in form of the roman V called the
Hyades, (whereof aldebaran is one of the top of the V).
The other is a clufter of ftars in his neck, (commonly
called the feven ftars, and known to every boy in the ftreets:
called in the fcripture (Job 9. 9.) the Pleiades. The other
ftars in this conftellation are eafily known, by the places
they poffefs in the image, whether it be in his horns, legs,
face, neck, &c. as I fully fhewed you in the laft year's
Diary.

The third conftellation in the zodiack is Gemini or the
Twins; and is characterized by two boys embracing one
another, thus, ♊.   D 2   The

The fourth fign, is Cancer or the Crab, and is known by a character of two oppofite eyes and horns, thus, ♋ : This conftellation hath none but fmall ftars only, two of them are of the third magnitude, that in the breaft is called præfepe, much celebrated by the ancient poets ; as are alfo the other two called the north and fouth affelli.

* The fifth fign in the zodiack is Leo or the Lion, which the ancients agreed to be defigned or characterized by a lion's tail turned upright thus ♌, containing 43 ftars, whereof 2 are of the firft magnitude, viz. the lion's heart, called Regulus ; and the lion's tail, called Cauda Leonis, and is a very fair ftar. There are alfo in this image 2 ftars of the fecond magnitude ; namely, one on the top of his loins, and the other in his neck ; by which 4 ftars all the reft may be eafily known.

The fixth fign is Virgo, or the Maid or Virgin, which is denoted by the folds or hems of a woman's garment in this manner ♍ ; of above 40 ftars, and hath one confiderable one of the firft magnitude, called Spico Virginis, or vinde-miator.

The feventh fign in this circle is called Libra, or the ballance or pair of fcales, which they have portraicted in the fimilitude of a ballance in this manner, ♎ confifting of 14 ftars, whereof 2 are of the fecond magnitude, viz. one in the fouthern-fcale, called lanx meridionalis, and the other is fometimes called bilanx.

† The eighth fign is Scorpio, or the Scorpion, defcribed by the knoted tail and fting of a ferpent thus, ♏ which hath one of the firft magnitude, called Cor Scorpionis, or the Scorpion's Heart, and one of the fecond magnitude in the head.

The ninth fign is Sagittarius, or the Archer, which the ancients have noted with the portraicture of an arrow thus, ♐ ; called alfo the Centaur ; it confifts of 30 ftars, two whereof are of the fecond magnitude, one in the knee of his right leg, and the other in the heel of the fame leg. Between his two forefeet is placed another fmall conftellation called the Southren crown, (corona auftrina.)

The tenth fign is Capricorn, or the Goat, which antiquity noted with a goat's foot tied in a ftring thus, ♑ ; confifting of twenty eight ftars, but none of them either of the firft or fecond magnitude.

The eleventh fign is Aquarius, or the Water-bearer ; which the ancient aftronomers have depictured by the waving of water thus ♒ ; having 42 ftars in it, but none of any confiderable magnitude.

The twelfth or laft fign of the zodiack is Pifces, or the Fifhes, and this image is reprefented by two fifhes bound together

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* *From the diary for* 1712.   † *For* 1713.

gether thus, ♓; which contains 36 ſtars, but none of them either of the firſt or ſecond magnitude*.

† As the ancients did neatly characterize the 12 ſigns, ſo likewiſe did they depict the 7 planets in like manner, which I ſhall now alſo ſhew you.

Saturn is depicted like an old man leaning upon a Staff, after this manner ♄.

Jupiter

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* Our author dying before he had compleated the deſcriptions of all the conſtellations, as he had promiſed and intended, I ſhall here ſupply the defect by ſubjoining the whole catalogue of conſtellations and number of ſtars upon each, as now generally uſed.

I. The twelve conſtellations in the zodiack, with their characters and number of ſtars, are thus :

		Stars				Stars.
1 Aries —	♈	20	7 Libra —	♎	—	20
2 Taurus	♉	53	8 Scorpio	♏	—	25
3 Gemini	♊	33	9 Sagitary	♐	—	22
4 Cancer	♋	31	10 Capricorn	♑	—	30
5 Leo —	♌	45	11 Aquarius	♒	—	49
6 Virgo —	♍	50	12 Piſces —	♓	—	39
	Sum	232				185
						232

The ſtars in the zodiack are 417

II. The 28 northern conſtellations are

	Stars			Stars
1 Urſa minor —	19	15 Perſeus —	40
2 Urſa major	39	16 Auriga —	27
3 Draco —	37	17 Serpentarius —	31
4 Cepheus —	34	18 Serpens —	18
5 Camelopardalus —	28	19 Sagitta —	8
6 Jordanus —	31	20 Aquila —	24
7 Bootes —	38	21 Antinous —	12
8 Corona Borealis —	9	22 Delphinus —	11
9 Hercules —	34	23 Equiculus —	4
10 Lyra —	17	24 Pegaſus —	25
11 Tygris —	38	25 Andromeda —	34
12 Cygnus —	29	26 Triangulum —	5
13 Sceptrum —	17	27 Irinus —	7
14 Calliopeia —	30	28 Coma Berenices —	13
	400		259
			400

Northern Stars 659

Jupiter is reprefented like a king bearing a fcepter thus ♃.

Mars is noted by a war-like engine, thus ♂.

The Sun by a round figure, thus ☉: and fometimes by a figure beamed about after this manner ✹.

Venus is figured in the fhape of a young maid, thus ♀.

For Mercury they drew a young man with wings in his cap, after this fafhion ☿.

And laftly, for the Moon, they marked, it horned, thus ☽ or thus ☾, as fhe appears in her quarters.

The author, at the bottoms of the almanack pages for 1710, thus defcribes the conftellations, in verfe.

The northern conftellations.

Within the glorious firmament, the fky,
Doth eight and forty conftellations lie.

Firft

III. The 37 fouthern conftellations are

	Stars		Stars
1 Cetus — — — 28		20 Phœnix — — — 13
2 Orion — — — 60		21 Indus — — — 12
3 Eridanus — — — 36		22 Pavo — — — 14
4 Lepus — — — 13		23 Apus — — — 11
5 Canis major — — 19		24 Mufca — — — 4
6 Columba — — — 11		25 Cameleon — — 10
7 Canicula — — — 11		26 Tringulum auftrale — 5
8 Mohoceros — — 23		27 Pifcis volans — — 7
9 Navis — — — 46		28 Dorado — — — 4
10 Hydra — — — 29		29 Nubes — — — 3
11 Crater — — — 11		30 Toucan — — — 8
12 Corvus — — — 9		31 Hydrus — — — 10
13 Grux — — — 4		32 Nubicula — — 3
14 Centaurus — — 35		33 Rhomboides — — 4
15 Lupus — — — 21		34 Royal Oak — — 10
16 Ara — — — 7		35 Lynx — — — 19
17 Corona auftralis — 13		36 Vertagus — — — 23
18 Pifcis auftralis — — 17		37 Unicorn — — — 19
19 Grus — — — 13		
		179
406		406

Southern ftars 485
Northern ftars 659
Zodiacal ftars 417

Stars in all 1661

But thefe are not to be underftood as the number of all the perceptible ftars, but only of thofe now put upon celeftial globes. The britifh catalogue contains 3001 ftars, though it confifts of fewer conftellations than the above.

First near unto the cold and northern pole,
The dragon lurks, and both the bears do rowl.
(The hinder parts of each, fev'n ftars contain,
Called the lefſer, and the greater-wain,)
The hare comes next, the bear-ward, and the crown,
Then hercules advances kneeling down:
Great ferpentarius riding on his fnake,
Doth next a formidable image make.
Under the tuneful harp of Orpheus
Are plac'd the Eagle, and Antinous.
The filver Swan her downy wings do fpread
Above the dart, and fportive Dolphin's head.
Then Pegafus comes flying on amain,
Andromeda next follows in her chain:
(The Triangle at a fmall diſtance ftands,
And at her feet you fee in Perfeus's hands,
The monftr'ous Gorgon's head; above are feen
Cepheus, with Caffiope his queen.
Auriga with his goat and kids appear
At laſt, which ends the northern hemifphere.

The twelve figns, or conſtellations of the Zodiack.

Between the north and fouth, all round the fky,
Juſt in the midſt, twelve conſtellations lie
We call the figns ; and firſt the Ram begins,
The Bull next follows, then the loving Twins.
The Sea-Crab, Lion, and the Virgin tender ;
Then comes the Balance, Scorpion, and Bow-bender ;
The bearded Goat, next follows in the train,
The Waterman comes next, then Fiſhes twain,
Do bring you round unto the Ram again.

The fouthern conſtellations.

Within the fpace o'th' fouthern hemifphere,
No more than fifteen images appear ;
The monftrous Whale claims place before the reſt,
Eridanus's ſtreams flow near his breaſt.
The Hare is next, and then Orion bright,
Who fhines moſt glorious in a winter's night.
Then comes the great dog Sirius, at whofe tail
The famous Argo fpreads her yielding fail ;
Above her maſts the little dog doth flame:
(This conſtellation hath no latin name.)
Next Hydra ſtretcheth out her tail afar;
The Crow and Pitcher, near it feated are :
The monftrous Centaure holds the Wolf by th' heel ;
Then comes the Altar and Ixion's wheel.
The fouthern fifh at laſt brings up the rear,
And thus you have the fouthern hemifphere.

Above

About the southern pole, far diftant be
Twelve conftellations, which we cannot fee ;
They're call'd the Craw, the arabian Phœnix, and
The Indian man, with three darts in his hand.
The bird of paradife, the little fly ;
The fine tail'd Peacock, the Camelion fly ;
The fouth Triangle, and the fouthern Snake ;
The Toucon Goofe with its long monftrous Beak ;
The fifh Dorado, and the flying Fifh ;
Two magellanick clouds likewife there is.

1713

*Of the reafons why the antients brought the
ftars into thefe figures and reprefentations,
according to Dr. Hook, and fome others.*

AND firft the ftars, if not precifely, yet after a fort, do
reprefent fuch a figure as they have depicted it by : thus
the three ftars over the head of the ram, that is in the fhape of
a triangle in the heavens, they have drawn upon the globes
and maps of the fixed ftars, the figure of a triangle : and
the feven ftars in the tale and back, both of the great
and little bear, is called the greater and leffer wain or
waggon ; becaufe it pretty well refembles it, and fo doth
the crown and fcorpion as fome people imagine.

A fecond reafon was, to continue the memory of fome
notable men, who either in regard of fome mighty and
fignal atchievement done, or in regard of their fingular
pains taken in advancing aftronomy, had deferved well of
mankind ; fuch as Hercules, Perfeus, and others.

A third reafon was (according to the fuperftition of the
antients) that thefe images exprefs fome properties of the
ftars that compofe them ; as thofe of the ram, to be hot
and dry ; Andromeda chain'd, betokeneth imprifonment :
the head of Medufa cut off, fignifieth the lofs of that part :
Orion with his terrible and threatning gefture, importeth
tempefts and dreadful effects : the Serpent, the Dragon,
and the Scorpion, fignifie poifon : the Bull infinuateth a me-
lancholy paffion : the Bear inferreth cruelty, and the like.

And laftly, befides all this, the poets had this defign touch-
ing the reafon of the invention of thefe conftellations,
namely, to make men fall in love with aftronomy ; they
fay that aftronomy being of fingular advantage to the life
of

of man, was almoft utterly neglected; hereupon, they began to fet forth, that under fictitious and delightful ftories, that thereby fuch as could not be perfwaded by advantage, might by the pleafure be induced to take a view of thefe matters, and thereby at length fall in love with them. Some of thefe poetical ftories you may have hereafter.

1711

How to know the fixed Stars.

But cries the fair-inquifitive, by what means or ways muft I know thefe ftars in the heavens?

I anfwer. There are divers ways or helps to know them; fome of which I fhall here put down.

1. The firft way then to know the ftars, is, by having the picture or reprefentation of the conftellations by you, and knowing one or more ftars in the heavens of the fame conftellation, by comparing the ftars in the picture or figure, and thofe in the heavens, and confidering their fituation, diftances, and magnitudes in the one, you may eafily find out thofe in the other.

Thus for example, I would know the ftars in the heavens of the conftellation Taurus: I take the picture in my hand, and go out in fome fair Night, and viewing the heavens, I find out the little clufter of ftars called the feven ftars, (known almoft by every body.) Then I look upon my picture, and obferve, (holding the backfide of it towards that part of the heavens, and the picture of the conftellation towards me.) I fay I obferve in the picture thus held, a large bright ftar bigger than all the neighbouring ftars, that is further from me, (or nearer to the earth) and more towards the eaft or left hand, called Aldebaran: then I look up into the firmament, and there obferving the fame pofition, and bignefs of the ftars, I foon find out Aldebran; or the Bull's fouth eye.

Having found out this ftar, I look again on it, and in the figure of this conftellation, I find five ftars placed * * as in the margin, like a figure of five, or the Roman V. * * One of the 5 ftars on the top of the roman V being Al- . * debaran, which I juft now found out; and that thefe five ftars make up a fmall conftellation, called the Hyades, I look then in the heavens, and confidering Aldebaran as one of the tops of this V. I foon find out the Hyades, and that the other ftar is the northern eye of Taurus. Now I would find out the two horns of the bull (or rather the two ftars at the tips of his horns. To do which, I view my conftellation or picture, and obferve, if I imagine a line from the fingle ftar at the bot-tom of the V or Hyades, I laft found out, to be extended ftreight forwards on one fide, and on the other fide the V, each

line will go a little without side the north-horn, and the south-horn, both being towards the east or left hand of the V. Otherwise I may do thus; I find in it, that the Pleiades, (or 7 stars) and the Bull's eye (or Aldebaran) and the Bull's north-horn make a triangle; the sides from the Pleiades and from Aldebaran being pretty near equal, and something farther in distance, than it is from the Pleiades to Aldebaran; I look then in the heavens, and soon find the north star out. and by that the south horn is easily found, being nearer towards the earth and about half the distance, as it is between the Pleiades and Aldebaran.

Or I might consider the Pleiades and Aldebaran, and the north and south-horns as a Trapeza, or 4 sided figure, and that the two nearest stars, (or shortest side) is towards the left-hand; and by this means find them out in the heavens: And the like may be done for the finding out of any other stars, in this constellation, or of any other, from the knowledge only of but one or more stars therein.

If you suppose a line drawn from Aldebaran, to the Pleiades, and continued near double their distance farther, you will find out the triangle over the Ram (or Aries) and by that you may find out the rest of the Ram as before directed.

Or if you imagine lines drawn from the Hyades, by the north and south horns of the Bull, and continue them about double that distance, they will include two bright stars, called Castor and Pollux, in the sign Gemini; from which, and the printed constellation above, the others may be easily found out; and the like for all the rest.

2. A second way is by the passing of some of the planets, but especially the moon through the signs, or by some eminent stars, to find them out.

3. A third way to know the fixed stars, (and also the planets by) is when they come to south, and if withal you have their height given, and then by a quadrant, find their heighth in the heavens, you may with great certainty and ease find them out.

4. A fourth way, is by their rising and setting.

5. A fifth way to know the fixed stars, is by some instrument, or by the globes.

Of the Eclipses this present year, 1704.

This year there will be 4 eclipses, whereof two will be of the sun, and two of the moon, but none can be seen in England, but a small one of the moon, which happens upon the thirtieth day of November: Its beginning will be about a quarter of an hour past six in the morning; the greatest darkness will be at half an hour past seven; and its end at half an hour past eight a clock; and she will set eclipsed *.   *Of*

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* *Of these eclipses I find no observations.*

Of the Eclipses this present year, 1705.

There will be but two eclipses this year, and both of the sun, and both of them invisible to us in England. The first of them on the 11 of May, about eight a clock in the evening. The other upon gunpowder treason day, at two a clock in the afternoon †.

The times of the Eclipses this year, 1706.

There will be four eclipses this year. The first of the moon, April 16. it begins at 5 minutes after midnight, greatest obscuration at 18 min. after one the next morning, and ends 32 min. after 2. digits eclipsed 5. The second is a great eclipse of the sun on May day‡, of which see in the beginning. The

                                                   third

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† Of these eclipse also I find no observations on record.

‡ As accurate observations of eclipses may be of use in determining the degree of accuracy that obtains in astronomical tables ; either by comparing the observations with the calculations which we find made by any one (supposing him to have calculated truly), or with accurate calculations which any person may make for that purpose ;. I shall subjoin, by way of notes, to every years predictions, such observations of eclipses as I find recorded in the *Philosophical Transactions, Leipsic Acts*, &c. And shall here begin with that on May $\frac{1}{12}$ (viz. 1st day old style, or 12th of the new) this year, it being the first I find upon record.

In the *philosophical transactions* are these following observations : which however are not the most perfect, on account of the frequent clouds which often covered the sun.

1. At *Greenwich*, by Mr *Flamstead*.

Correct time by the pend. Clock.			
h.	m.	s.	
8	21	30	A very small part of the sun's diameter was eclipsed.
8	28	00	The chord of the arch of the sun's periphery eclipsed was 14′ 40″.
9	21	46	The parts of the diameter remaining clear 5′ 40″. †
9	26	20	The same — — — — 4 30.
10	31	50	The sun appeared through the breaks of the clouds and shewed the eclipse not ended. Clouds again till
10	33	50	When the sun shone out again, we saw his limb intire, and the eclipse certainly over.

                                                   2 &c.

third is of the moon, Oct. 10. It begins nineteen minutes after
6 in

2. At *Canterbury*, by Mr S. *Gray*.

Correct time by the pend. clock.	
h. m.	
8 53	digits 5½ darkened.
9 08	——— 7
9 31	——— 10 or more
9 36	The sun shining for a short time, the eclipse seem'd to decrease.
9 55	——— 7½ a little clearer.
9 57	——— 6¼
10 02	——— 6
10 04	——— 5¾
10 14	——— 4
10 16	——— 3¾
10 20	——— 2½
10 30	——— 1
10 31	——— 0¾
10 36¼	The end accurately with a tube of 16 feet.

3. At *Horton* near *Bradford* in *Yorkshire*, by Mr *A. Sharp*.

Correct time.	
h. m. s.	
8 35 00	digits dark 3 } by ocular estimation.
9 01 00	——— ——— 7 }
9 04 54	——— ——— 8 3/10 eclipsed on the scene.
9 06 33	——— ——— 8½
9 07 53	——— ——— 8 6/10
9 12 50	——— ——— 9
9 16 08	——— ——— 9 4/10
9 18 48	——— ——— 9½ exactly, the sun shining out clear.
9 20 45	——— ——— 9½ the sun still clear. Greatest obscurity.
9 21 48	——— ——— 9½ still clear.
9 28 46	——— ——— 9
9 44 45	——— ——— 7
9 54 42	——— ——— 5¼
10 06 10	——— ——— 3¼
10 19 55	——— ——— 1 precisely.
10 24 00	The sun seen through clouds; the eclipse not ended.
10 30 00	The sun seen again perfectly round and intire.

4. At *Bern* in *Switzerland*, by Capt. *Stannyan*.

Captain *Stannyan*, from *Bern* in *Switzerland*, writes, that the sun was totally darkened there for 4½ minutes of time; that a fixed star and a planet appeared very bright; and that *his getting out of the eclipse was preceded by a blood-red streak of light, from its left limb, which continued not longer than 6 or 7 seconds of time*; then part of the sun's
disk

6 in the evening, greateſt obſcuration 38 min. after 7, ends
about

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diſk appeared, all on a ſudden, bright as venus was ever ſeen in
the night ; nay, brighter ; and in that very inſtant gave a light and
ſhadow to things, as ſtrong as moon light uſes to do.

Upon this the writer of the tranſactions obſerves that

The Captain is the firſt man I ever heard of, that took notice of a
red ſtreak of light preceding the emerſion of the ſun's body from a
total eclipſe : and I take notice of it, becauſe it infers that *the moon
has an atmoſphere* ; and its ſhort continuance of only 6 or 7 ſeconds
of time, tells us, that *its height is not more than the 5 or 6 hundredth
part of her diameter.*

5. At *Geneva*, by *Mr J. C. Facis* Duillier.

This gentleman could ſee neither the beginning nor end of the
eclipſe ; and all that can be collected from his account, is that the
duration of the total darkneſs or total immerſion was preciſely 3
minutes ; that during the time of the total darkneſs, a whiteneſs
ſeemed to break out from behind the moon, and to encompaſs it
on all ſides equally, its breadth being leſs than one-twelfth of the
moon's diameter, and was but ill determined in its outward ſide ;
that a little after the ſun began to appear again, the whiteneſs en-
tirely vaniſhed ; and that ſeveral ſtars and planets were ſeen.

The ſame gentleman ſaith that, according to *Mr* Profeſſor
Gautier's obſervations, from the emerſion of the ſun to the end of
the eclipſe, there was 1 h. 9 m. 30 s.

He alſo ſaith that the ſame gentleman communicated to him the
following obſervations made

6. At *Marſeilles* by *Mr Chazelles* and *Father Laval.*

			h.	m.	s.
At *Marſeilles* the eclipſe began at — — —			8	28	40
It reached the ſun's center at — — —			9	6	11
It was total at — — — —			9	34	15
The ſun began to appear again at — —			9	37	9
The eclipſe came again to the center at — —			10	12	23
It entirely ended at — — — —			10	47	50

Three ſtars were diſtinctly ſeen ; and during 3 minutes it was not
poſſible to read. And there remained one bright digit, all about
the globe of the moon.

The manor houſe of *Duillier* is in the latitude of 46° 24'; in longi-
tude it is 4° 13' 45" to the eaſtward of the royal obſervatory at
Paris. And *St Peter's Church* at *Geneva* is, in latitude, 0° 11' to the
ſouthward, and, in longitude, 0° 5' 2" to the weſtward of *Duillier.*

7. At *Zurich*, by *Dr J. J. Scheuchzer.*

We have had here, may 12, both a total and annular eclipſe of
the ſun ; total, becauſe the whole ſun was covered by the moon ;
annular,

about 4 min. before 9, digits eclipfed 7 and three fourths. The fourth

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annular, though not properly fo called, but by refraction, for a ruddy brightnefs appeared about the moon, arifing from the rays refracted by the moon's atmofphere.

	h.	m.
The beginning of the eclipfe was in the morning	8	54
The middle — — — — —	9	58
The end — — — — —	11	12

The mora of the mean and full obfcuration 4m.

Both the fixed ftars and planets might be feen. The birds betook themfelves to their nefts. The bats came out of their holes, and the fifhes fwam upon the water. We ourfelves perceived a fenfible degree of cold, and the dew fell down upon the plants.

The following obfervations, of the fame eclipfe, are extracted from the *Leipfick Afts of the Learned.*

8. At *Leipfick.*

	h.	m.	s.
The beginning of the eclipfe at about —	9	15	0
The greateft darknefs — —	10	25	20
The end — — — —	11	35	45
The duration of the eclipfe about —	2	21	0

There was fcarcely one-third of a digit of the fun's difc uneclipfed; and feveral fixed ftars, with the planets mercury, venus, jupiter, and faturn were vifible. A fhining ring was alfo obferved furrounding the moon, parallel to its limb ; it was denfer in that part towards the moon, and rarer in the other part which was fartheft from it ; but it was, neverthelefs, bounded by a very accurate periphery, and plainly to be diftinguifhed from the uneclipfed part of the fun, which was above it towards the zenith. It was lefs than the uneclipfed portion of the fun's difc, and its brightnefs was like that of filver. The edge of the moon was pale like clouds, whilft the inner part of the difc was quite black.

9. At *Jena (viz. Eyfenach or Ifenack,* in the Marquifate of *Thuringia* in *Upper Saxony)* by profeffor *Hambergerus.*

	h.	m.	s.
The beginning — — — —	9	11	40
The middle — — —	10	21	59
The end — — — —	11	32	18
The whole duration — —	2	20	38
The digits eclipfed 11¼.			

When the darknefs was greateft, he faw venus, jupiter, and capella. And fo great was the darknefs, that he was obliged to light a candle, in order to difhinguifh the minute and fecond pointers of his pendulum clock, which was placed in the window.

10. At

fourth is of the fun, oct. 25*. at 3 in the afternoon, invisible.
The

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10. At *Berlin.*

			h. m.
The beginning	—	—	9 24'
The end	—	—	11 45
The digits eclipfed were 11⅞			

11. At *Uratiflavia* (viz. *Breflaw* in *Silefia*) by R. P. *Chriftopher Heinrich*, profeffor of divinity and mathematics.

				h. m. s.
The beginning of the eclipfe	—	—	—	9 39 40
The beginning of total darknefs	—	—	10 49 0
The middle	—	—	—	10 49 30
The end of total darknefs	—	—	10 50 0

				h. m. s.
The end of the eclipfe	—	—	—	12 2 20
The duration of total darknefs	—	—	0 1 0
The duration the eclipfe	—	—	2 22 40

The diameter of the moon exceeded that of the fun by only 15″ of the fun's diameter.

At the time of the total darknefs, feveral ftars were very eafily feen, efpecially two near the fun. And a circle of a faintifh light furrounded the moon like a halo.

At 10 h. 6 m. 30 s. when 5 digits of the fun were darkened, a parabolic fpeculum, of 3 feet diameter, juft fet fire to dry wood; which it would not do at 10 h. 18 m. 20 s. when 7 digits were eclipfed.

At 10 h. 35 m. 30 s. when 10 digits were obfcured, it juft fcorched a piece of rag.

At 10 h. 42 m. 0 s. when 11 digits were darkened, it would not fire any inflammable fubftance.

A burning lenfe, 9½ inches diameter, when 9 digits were eclipfed, at 10 h. 30 m. juft fcorched the rag; but when 10 digits were darkened, it would no longer light any inflammable matter.

The fky, during the whole time, was remarkably ferene.

* In the philofophical tranfactions it is recorded that This eclipfe was obferved at the town of *S. Ignatius* in Paragua, where the altitude of the fouth pole is 26° 52', and its merid. dift. from the R. obferv. at *Paris* 3 h. 57 m. 50 s, by *F. Bonaventura Suarez*, miffionary to that place.

					h. m.	
Beginning of the eclipfe, Nov. 5 N. S.	—	8 52	*A. M.*
Digits obfcured	2	—	—	—	at 9 15
	3½	—	—	—	9 40
	4	—	—	—	10 0
	2	—	—	—	11 5
The end at	—	—	—	—	11 15

The greateft quantity 4 dig. at 9 h. 50 m. The times by a pendulum, rectified to true time, by the altitude of the fixt ftars.

† This

1707

The Eclipses this year.

There will be fix eclipses this year. 1. A fmall eclipfe of the fun at his fetting mar. 22 invifible. 2. A total eclipfe· of the moon †april 6. of which fee in the beginning. 3. An invifible fmall eclipfe of the fun on april 21, at 2 in the morning. 4. A very fmall eclipfe of the fun fept. 14 about midnight. 5. A great eclipfe of the moon at noon day fept. 30. invifible. 6. An eclipfe of the fun october 14, about 3 a clock in the afternoon, but invifible to us.   A famous ☌ ♃ ♂ in ♍ july 9 at 10 at night.

Two Arithmetical Enigmas.

1. In how long time would a million of millions of money be in telling, fuppofing one hundred pounds to be counted every month, (without any intermiffion day or night, funday or work-day) till all be told?

2. If to my age there added be
One half, one third, and three times three;
Six fcore and ten the fum you'ld fee,
Pray find out what my age may be?

The

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† This eclipfe was obferved as follows :

1. At *Bofton* in *New England*, by Mr. T. *Brattle.*

Time corrected.
by altitude.

April 5. N. S.

	h. m. s.	
A very notable penumbra	— 6 52 0	P. M.
The moon quite immerfed	— 8 1 15.	
The moon plainly began to emerge	— 9 46. 30	
The moon is fully illuminated	— 10 54 0	

2. At *Zurich*, by the two Doctors, *Scheuchzer's.*

	h. m. s.	
The penumbra on the fide of *marætis*	— 12 9 18	night.
The true fhadow within the difc	— 12 18 40	
The whole body of the moon in the fhadow	1 23 20	morn.
The true beginning of the emerfion	— 3 9 40	
The penumbra — — —	4 13 40	
All the moon entire — — —	4 14 20	
The duration of total obfcuration	— 1 46 30	
The whole duration of the eclipfe	— 3 55 50	
From the beginning to the total immerfion	1 4 40	
From the emerfion of the total eclipfe to the end	1 4 40	3. At

`L`

1708

The Eclipses of this Year.

In this year will be four eclipses, namely, two of the fun, and two of the moon. The firft is of the fun, the 11th of march, near 7 in the morning, but invifible to us.   The 2d* is of the moon, march 25, about 6 in the morning: fhe will be above half eclipfed, but not much vifible, becaufe the fun will rife before the middle of the eclipfe.   The 3d † is of the fun, feptember 3, about 9 of the clock in the morning; it will be a vifible eclipfe, and about a third part of his diame-
ter: -

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3. At *S. Ignatius*, by the miffionary *F. Bon. Suarez*. -

April 16, N. S.   h. m.

Beginning   —   —   —   —   7 55 P: M.: -
Total obfcuration   —   —   —   —   8 58
Beginning of emerfion   —   —   —   10 45 >
The end was not obferved becaufe of clouds.

*· This eclipfe was obferved at *Paragua*, by *F. Bonaventura Suarez*, - thus : 1708 april 4 P. M. N S.

Immerfion of the moon			Emerfion of the moon.		
	h. m. s.			h. m. s. ·
Into afenfible penumbra	11 18 0	Ariftarchus ‘ —	14 13 15 >
Into the fhadow —	12 30 29	Plato — —	14 15 0 ·'
Ariftarchus obfcured ·	12 13 11	Out of the fhadow	15 3 0 ·
Plato obfcured —	12 46 0	Out of the penumbra	15 12 0

† This eclipfe was obferved at *Upminfter*, by Mr *Derham*, thus :

The correct app. time	
h. m. s.	
6 44 15	The beginning could not be feen for clouds. · ·
	The fun peeped out of the clouds, and about one-tenth + of a digit was eclipfed. Then clouds moft + of the time. But at·
8 31 15	A little obfcuration appeared through the telefcope.
8 32 45	A very little obfcuration through the telefcope.
8 35 45	We could difcern no remains of the eclipfe through the · telefcope.

From thefe obfervations I imagine the end of this folar eclipfe was much about 8h. 33m. in the morning.

ter, will be hid on the north part. The 4th * will be of the moon, september 18, near nine at night; it will be about 5 digits and a quarter eclipsed, and may be seen if the night proves clear.

A Letter to the Author.

SIR,

REading in a book of geography the other day, I found to my great surprise, the following paradoxes.

There is a certain place in the globe, of a considerable southern latitude, that hath both the greatest and least degree of longitude.

There are three remarkable places on the globe, that differ both in longitude and latitude, and yet all lie under one and the same meridian.

There is a certain island in the baltic sea, to whose inhabitants the body of the sun is clearly visible in the morning before he rises, and likewise in the evening after he is set.

There is a certain village in the kingdom of Naples, situate in a very low valley, and yet the sun is nearer the inhabitants thereof every noon by 3000 miles and upwards, than when he either riseth or setteth to those of the said village.

There

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* At *Upminster* Mr *Derham*, observed it, and records it thus:

As I was coming from *London*, sept. 18, in the evening, I observed, for half an hour or more, a thin shade to possess that part of the disc where the eclipse began, which remained a good while after the eclipse was over. After I got home, I got all things in readiness before the eclipse began. The principal observations were as follow:

The correct app. time.	
h. m. s.	
7 56 30	A thin penumbra.
7 57 40	A darker penumbra.
7 59 0	Yet darker, which may pass for the beginning of the eclipse.
8 0 0	The eclipse no doubt begun.
9 1 0	The lucid parts of the moon, not long before the middle of the eclipse, were 925 parts of my micrometer.
9 16 40	Diameter of the moon 1634 parts of the micrometer.
10 23 11	The end of the eclipse draws nigh.
10 25 0	A little obscuration.
10 26 0	Less.
10 28 15	A very little, excepting the duskishness before mentioned.

There is a certain remarkable place of the earth, of a confiderable fouthern latitude, from whofe meridian the fun removeth not for feveral days at a certain time of the year.

There are ten places in the earth diftant from one another 300 miles and upwards, and yet none of them have either longitude or latitude.

Thefe things, Sir, to me feem impoffibilities; I fhould be glad to know your opinion of them in your next Diary.

I am, Sir, yours, &c.

The Anfwer.

S I R,

ALL thefe particulars are very true, as I fhall plainly make appear in my next.   *I am, Sir, yours,*

Coventry, Auguft
the 9th, 1707.

J. T I P P E R.

The Arithmetical Queftions.

In my laft, I fet down two arithmetical queftions. The age of the perfon in the fecond queftion, is 66 years.* But the firft Queftion was falfely printed, a month being put down for a minute; I have therefore here repeated it again, with four more which I have received from feveral parts of the kingdom.

Arithmetical Queftion 1.

In how long time would a million of millions of money be in counting, fuppofing one hundred pounds to be counted every minute without intermiffion, and the year to confift of 365 days, 5 hours, 45 minutes?

Queftion 2.

A gentleman a garden had,
Five-fcore foot long, and four-fcore broad,
A walk of equal breadth, half round
He made, that took up half the ground;
(The figure in the margin fee,)
How wide's the walk pray tell to me?
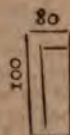
Queftion

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*The meaning of the problem is, that the number 9 added to once his age together with one-half and one-third of his age, the fum fhall be 130; or, fince the fum of the parts 1, and $\frac{1}{2}$, and $\frac{1}{3}$ is $\frac{11}{6}$, that $\frac{11}{6}$ of his age is (130—9=) 121; confequently 11 : 6 :: 121 : 66 = his age.

Question 3.

If thirteen tun of claret wine, cost nineteen English pounds;
How many pints of the same wine, are worth a thousand
crowns?

Question 4.

If thirteen marks and fourteen groats, buy fifteen loads of
hay;
How many pounds, with sixteen crowns, for ninety loads
will pay?

Question 5.

When first the marriage knot was ty'd
  Betwixt my wife and me,
Mine age did hers as far exceed
  As three times three, doth three:
But after ten and half ten years
  We man and wife had been;
Her age came up as near to mine
  As eight is to sixteen.
Now tell me, if you can, I pray,
  What was our age o' th' marriage day?

1709.

Answers to the geographical paradoxes propounded in the last year's diary.

Solution of Paradox 1.

ALL places that lie under the first meridian, have both the
greatest and least degree of longitude, and from any of
them you may begin or end your reckoning, let the latitude
be what it will; and the words of a considerable southern lati-
tude, are but a blind to make the question more obscure:
for as we say of the moment of time when it is noon (ac-
cording to astronomers) that it is the end of the former day,
or the beginning of the ensuing; so we may say of all places
under the first meridian, that they be the greatest number of
degrees of longitude that can be, or otherwise the beginning
and least number thereof.

Solution of Paradox 2.

By the globe is here meant the artificial globe, and the me-
ridian the brazen circle belonging thereto; then admit the
first

firſt place was in 10 deg. of longitude, and under the tropick
of cancer; the ſecond place under the north pole; and the
third lie under 8 deg. (or any other number from the equator)
but in the oppoſite meridian: then it will follow, that the firſt
place hath 10 deg. long. and 23 deg. and a half lat. The ſe-
cond place hath 0 deg. lon. and 90 deg. lat. and the third place
hath 190 deg. long. and 8 deg. lat. and all lie under the ſame
brazen meridian, which anſwers all the conditions of the
paradox.

Solution of Paradox 3.

In order to ſolve this paradox, it is neceſſary to know the
nature of refraction, and what is the cauſe thereof, which I
ſhall endeavour to explain in a few words.
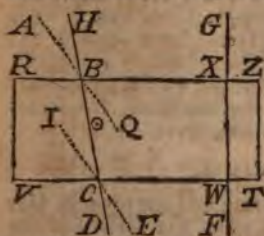
Suppoſe a body of glaſs $R Z$
$T V$ in form of a parallelopipedon
or of an ordinary brick (the length
and breadth is $R Z$ and $Z T$, but
the thickneſs you muſt imagine).
Suppoſe from an eye at G in the
open air (being a light expanded
body) a ray of light fall perpen-
dicular upon the tranſparent (but
a denſe cloſe compacted body com-
pared to the air) it will paſs to the other ſide the glaſs W, and
ſo continue to F, without any refraction at all.

But if from the eye placed at A, the ray paſſeth obliquely
to B, it will not proceed in a direct line to Q, but bend or
be refracted (towards you) to C. And when it comes to C,
the ray will not continue in a ſtreight line from $B C$ to D.
But (coming out of a denſe body, to a more rare, light, and
expanded one,) it refracts towards E; and if the top and bot-
tom of the glaſs are parallel, the line $E C I$ will be parallel
to $Q B A$

Suppoſe now $A Q$ to be the horizon of ſome iſland in the
baltick ſea, (or elſewhere) when therefore the ſun comes
to Q, he is juſt truly riſen; yet by reaſon of the refraction
of the vapours and clouds near the horizon, he will appear to
an eye place at A, as if he was really riſen as ſoon as he comes
to $\odot$; and the ſame it will be after his ſetting in the evening,
which truly anſwers the demand.

This alſo ſolves the queſtion, why a piece of money in a
baſon filled with water, ſhall appear, which when it was
empty, could not be ſeen.

Solution of Paradox 4.

When the ſun riſeth in the horizon of any place, (be it
Naples or any where elſe) he is the ſpace of the ſemidiame-

ter of the earth more diſtant from that place, than when he·
is in its meridian at noon. Now there being but an inconſi-
derable proportion between the depth of the loweſt valley in
the world, and the ſemidiameter of the earth, (which is above
3600 miles) it follows, that the ſun muſt be 3000 miles and
upwards nearer at noon, than at his riſing, there being no·
valley the tenth part of 600 miles deep.

· Solution of Paradox 5.·

There are ſome that do ſay the place muſt be under the·
ſouth pole, but I take the ſolution to conſiſt rather in the e-
quivocalneſs of the words from whoſe meridian the ſun re-·
moveth not; for by this expreſſion is not meant, that the ſun
ſtands ſtill in the meridian, but that he conſtantly ſhines up-
on, or enlightens the meridian of the place, as long as he is·
above the horizon, which is in ſuch places beyond the
͵artick circle on which the ſun ſhines ſeveral days; as ſuppoſe
in 68 deg. ſouth lat. (for that latitude the queſtion requires)
for there the ſun departs not from the meridian, *i. e.* ſhines
upon it conſtantly, for 30 days together, *&c.*

Solution of Paradox 6.

The places are ſaid to be in the earth and not upon it; (for
longitude and latitude are reckoned upon the ſurface of the
globe only.) So the axis· of the earth (or any other imagi-·
nary line through it) being about 7200 italian miles, will not ·
only aaſwer the paradox; but if inſtead of twelve places,
he had ſaid twenty-four, it would have kept within the poſſi-
bility of the demand.

Moſt of theſe paradoxes were anſwered by Mr Robert·
Winſton, of Plimton, near Plymouth; and ſome of them by
Mr Moyle, of Gwennap, in Cornwal.

Of Arithmetical Queſtions.

A Rithmetical queſtions are as entertaining and delightful as·
any other ſubjeĉt whatſoever, they are no other than e-
nigmas, to be ſolved by numbers; and indeed the ſubtilty of
numbers are ſo ſtrange, that to them who are unacquainted
with them, would ſeem impoſſible, and many queſtions, that
in appearance ſeem a trifle, in conſequence exceeed all hu-
man belief. This puts into my mind a ſtory I have read in
Dr Willis's book, called opus arithmeticum. Namely, " that
" one Seſſa an Indian having firſt found out the game at chef-
" ſe, and ſhew'd it to his prince Shehram; the king, who
" was highly pleaſed with it, bid him aſk what he would for
" the reward of his invention; whereupon he aſk'd, that for
" *the firſt little ſquare* of the cheſs-board (or boards to play
" at

" at drafts on) he might have one grain of wheat given him;
" for the fecond, two; and fo on doubling continually accord-
" ing to the number of fquares in the cheffe-board, which was
" 64. And when the king, who intended to give a noble
" reward, was much difpleafed, that he had afk'd fo trifling
" a one; Seffa declar'd, that he would be contented with this
" fmall one. So the reward he had fix'd upon, was order'd
" to be given him: but the king was quickly aftonifh'd, when
" he found that this would rife to fo vaft a quantity, that the
" whole earth it felf could not furnifh out fo much wheat.

This ftory the doctor believes gave rife to that new quefti-
on concerning a horfe, which fhould be fold according to the
number of nails in his fhoes, by continually doubling of them;
and this likewife gave occafion to the firft arithmetical queftion
following, of a merchant felling fome extraordinary diamonds
being 64 in number, which I compofed on purpofe to anfwer
the queftion propounded in the ftory above recited, which
you fhall have anon afer I have fet down

The anfwers to the laft year's Arithmetical Queftions.

Anfw. to the firft is, 19013 years, 144 days, 3 hours, 38
minutes, fay fome; others agree in years and days, but fay it
is 5 hours 55 minutes.*

Anfwer to the fecond is, 26 feet near, or more truly
.2596875776257.†

                             The

---

* The folution of this queftion is evidently thus : As 100 l.: 1 minute
:: 1000000000000 l. : 10000000000 minutes $=$ 19013 years 144
days 5 hours 55 minutes, the true time required.

† This problem, I think, may be moft
elegantly conftructed thus : $A\ B\ C\ D$ being
the given rectangle, make $B\ E = B\ A$, and
$C\ F$ and $C\ G$ (on the diagonal) each
$= C\ E$; then making $A\ H = \frac{1}{2}\ A\ F$,
and $A\ I = \frac{1}{2}\ A\ G$; and compleating
the rectangle $A\ H\ K\ I$, the thing is done.
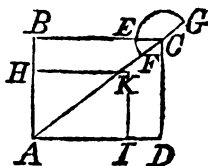
  For, the area $= H\ A \times A\ I = \frac{1}{2}\ F\ A \times$

$\frac{1}{2}\ A\ G = \dfrac{A\ C - \overline{C\ B - B\ A}}{2} \times \dfrac{A\ C + \overline{C\ B - B\ A}}{2} =$

$\dfrac{A\ C^2 - \overline{C\ B - B\ A}^2}{4} = \dfrac{C\ B \times B\ A}{2} =$ half the whole area.

  And $I\ A - A\ H = \dfrac{G\ A - A\ F}{2} = C\ F = C\ B - B\ A,$

as it ought.   The

The number of pints in the third queftion are 344842 $\frac{2}{15}$*

Anf. to the fourth qu. is, 49 l. 8 s. befides the 16 crowns.‡

The anfwer to the fifth and laft queftion I received in verfe, from Mr Proffer, as follows,

> When firft the folemn knot was ty'd,
> Your wife was juft fifteen;
> You by proportion forty-five,
> Which is as three to nine.
> But when your hoary head arriv'd
> To ten and half ten more,
> Your youthful bride faw thirty years,
> And you could tell threefcore.
> Thus have I told without delay,
> What was your age o' th' marriage day.†

                                                        Mr

The *numerical calculation* will come directly from the conftruction thus: The required breadth $H B$ is $= B A - A H = B A - \frac{1}{2} A F = B A - \frac{A C - \overline{C B - B A}}{2} = \frac{C B + B A - A C}{2} = \frac{100 + 80 - \sqrt{16400}}{2} = 90 - \sqrt{4100} = 25.96875762567 15.$

The Algebraic Solution.

Put $a = C B$, $b = B A$, $d = e - b$, and $z = A H$. Then $H A \times A I = z \times \overline{z + d} = \frac{1}{4} a b$; hence $z = \frac{\sqrt{2 a b + d d} - d}{2} = \frac{\sqrt{a a + b b} - a + b}{2}$, and $B H = b - z = \frac{a + b - \sqrt{a a + b b}}{2} = \frac{C B + B A - A C}{2} =$ half the femiperimeter minus half the diagonal, the fame as above.

* *Queft.* 3.—As 19 l. : 26208 pints $=$ 13 tuns : : 250 l. $=$ 1000 crowns : 344842 $\frac{2}{15}$ pints.

‡ *Queft.* 4.—As 15 loads : 90 loads : : 1 : 6 : : 178 s. $=$ 13 marks + 14 groats : 1068 s. $=$ the value of 90 loads. From which deducting 80 s. $=$ 16 crowns, leaves 988 s. $=$ 49 l. 8 s. or 49$\frac{2}{5}$ l. for the number required.

† *Queft.* 5.—Put z and 3 z for the two ages, and $a = 15$; then 2 : 1 : : 3 z + a : z + a, or 3 z + a $= 2$ z + 2 a; hence z $= a = 15$, and 3 z $= 45$.

But perhaps the more mafterly way of folving this problem is thus: fince 2 : 1 : : 3 z + a : z + a, fubtract each confequent from its antecedent, and we have   1 : 1 : : 2z : z + a;
                    but   1 : 1 : : z : z,   hence,
by fubtracting,   1 : 1 : : z : a; or z $= a =$ the *number added univerfally.*

Mr John White, of Butterly, in Devonſhire, ſends me word he overheard ſome of his plain country plow-men diſcourſing about the firſt queſtion (of counting the money) in their country dialect, the ſubſtance whereof was as follows.

Says Tom 'twol be vorty long days,
I and vorty to that ſays Will;
'Twant be told in a year quoth Jack,
No nor in zov'n years cries Jill;
You talk all like vools faith Roger,
A Merchant with's two vore veet,
Will ſcrape it away in a month,
And thereto I'll wage you a ſheep;
Go blockhead, quoth Beſs, that was brewing,
The boy that weighed my hops,
Woll tell it all in a week,
Zo will any mon in the ſhops.

All theſe arithmetical queſtions were anſwered by Mr John Jolly, of Buglawton, in Cheſhire; Mr John Boſwell, of Harliſton, in Northamptonſhire; Mr Robert Winſton, of Plymton; Mr Micock, and W. P.

The three laſt by the gentleman of Modbury; and by him who ſtiles himſelf Antenor; Mr Moyl; Mr Yates, of Henly, in Arden, &c.

The difference of the anſwer in the firſt queſtion ariſeth from this, viz. That after the firſt diviſion is ended, to find the number of years, one takes the remainder to be all minutes, and turns them into days, hours, and minutes directly. But the other makes the parts of the year, in the ſame proportion as the whole years, by multiplying the remainder, by the next inferior denomination, and dividing the product by the common diviſor, &c.

The eclipſes of this year.

This year there be two eclipſes, and thoſe both of the ſun. The firſt is a ſmall viſible eclipſe, on the 28th of february, about noon, or rather a little after; the digits eclipſed are 3. The ſecond is on the twenty-fourth of auguſt, it will be a great eclipſe, but to us inviſible, it happening to be about one a clock in the morning. *

Theſe eclipſes happening the one before, and the other after the ſuns apogæon, there can be no full-moon eclipſe this year *New*

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* From F. *Bonaventura Suarez's* obſervation of this eclipſe at *Paragua*, it appears that the eclipſe ended at 7 h. 37 m. 15 s. and that the greateſt obſcuration was 9½ digits. He ſaith, the ſun roſe at 5 h. 53 m, and that the eclipſe had begun before then.

F

New Questions.

I *Question* 6.

A rich indian merchant, had diamonds good ftore
Of extraordinary value, in the whole fixty four;
Who brought them to fell to a perfian king,
Who afk'd him the value each diamond would bring:
Quoth he for the firft ftone, I will have but one grain
Of your beft indian wheat, for the next, I'll have twain;
For the third, I'll have four grains, and for the fourth, eight;
So doubling the laft fum, till all are complete.
Done! done! (faith the king,) with a great deal of pleafure,
Who thought for a trifle he had purchas'd a treafure;
And calls for, (jocofely) a bag of wheat out,
Saying count, for there's more than enough without doubt.
But when for fome hours, the grains they did count,
They found to fuch vaftnefs the whole would amount,
That all the whole kingdom, and feveral more,
Could not yield fo much corn as would pay of the fcore.
The king being pleas'd with the merchants great wit,
Gave him good ftore of gold for his bargain to quit.
     Propofe now each bufhel of wheat worth a crown,
        And juft half a hundred did weigh:
     And fuppofe a corn-pint held ten thoufand wheat grains;
        Thefe two queftions anfwer I pray.
(1.) What number of horfe loads (* thoufand pounds each,)
        Muft be us'd to fupport this great treafure?
(2.) And how many fhips, each a hundred tun freight,
        Would fuffice to tranfport the wheat hither?

II *Question* 7.

     Quoth Jack to Tom, your Age and mine
     Are both the fame; and Valentine
     My eldeft fon's juft half my years,
     (As by the regifter appears.)
     If thefe three fums you multiply
     One in another continually,
     And to their product (drawn at length)
     Add five times fixty-eight, one tenth; (i. e. $340\frac{4}{5}$)
The whole to thirtythoufand will amount,
What is each age? come try your fkill and count?

III *Question* 8

A vint'ner would mix three forts of wine
Of various rates; the firft was very fine,
The price eight groats the quart; the other two
                Were

---

* Sterling filver money.

Were five and four groats each, now he would brew
Fifty fix quarts together, in fuch fort
To fell't for two and twenty pence a quart:
How many anfwers in whole numbers may
Be found to folve the queftion ; tell me pray ?

IV Queftion 9.

Sev'n men did buy a grinding-ftone,
   Of five foot in diameter :
And they agree among themfelves,
   That each fhall grind an equal fhare,
And that one man fhould firft begin
   To grind his feventh part off the ftone ;
And then another fhould grind his,
   And fo continue one by one.
How much each man for's part muft grind ?
Is what you are requir'd to find ?

V Queftion 10.

Thofe pendulum clocks, by experience is found,
Whofe fwing in a minute, make fixty rebounds,
(As by tryal you'll find if you meafure their lengths,)
Will contain juft thirty nine inches, two tenths.
If fo ; then how long muft that pendulum be,
That fhall make the fame number of fwings to agree
With the number of inches its length doth contain,
(In the fpace of a minute ;) I'd know very fain ?

1710.

Solutions to the laft year's queftions.

Solution of queftion 6, by a Lady.

Suppofe, (faith fhe) navigation to have begun with Adam,
and 67279 fhips of 100 tun each to have been built every year
fince the creation of the world, (which fhe fuppofes to be
about 5655 years;) and fo to build the fame number conti-
nually to the end of the world, and the world to laft 5000
years longer, and all thofe fhips to be in being at once ; all
of them together (according to the tenour of the quef-
tion) would not be fufficient to tranfport the wheat, fo pro-
digious is the quantity. She adds,

   For th' horfes muft be (as fure as your alive)
   Of millions, fev'n thoufand, two hundred, and five ;
   Of thoufands, fev'n hundred, fifty, and nine ;
   Of units four hundred, and three ; (very fine !)   To

To carry the cash, sir; and then 'tis as plain
Just so many ships will bring o'er the grain.
I shall not stand much on the fractional part;
E'en take it i' the bargain with all my heart.

i. e. 7205759403 horse loades, (besides 792*l.* 15*s.* 10*d.* odd money,) and the same number of ship-loads.*

Solution of *question* 7.

If thirty nine you multiply by thirty nine, 'tis plain,
That fifteen hundred twenty one you by that work will
   gain;
This drawn into nineteen, five tenths, the age of his first
   son,
To th' product add the *sum propos'd, and   *340 $\frac{1}{10}$
   so the work is done.

i. e. Jack and Tom's age is 39 years each and Valentine's 19 years and an half.†

Solution of *question* 8.

To mix the wine as you propose, there are no other ways
   but those,
Which are below in order plac'd, and had with jingling
   rhime been grac'd,
Would they not too much paper waste: besides, I'm now,
   sir, in great haste.

Best   10 11 12 13 14 15 16 17 18 19 20 quarts at 32*d.* each
Mean   44 40 36 32 28 24 20 16 12 8 4 quarts at 20*d.* each
Worst   2 5 8 11 14 17 20 23 26 29 32 quarts at 16*d.* each

Being

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* *Solution of* QUESTION 6. The number of terms being 64, the ratio 2, and the first term 1.; the sum of all the terms of the series will be $2\frac{^{64}-1}{2-1} \times 1 = 2^{64} - 1 = 18446744073709551615$ for the number of grains of wheat; which being divided by 10000 $\times$ 64 = 640000 the number of grains in a bushel, we have 28823036151711743984375 for the number of bushels; the value of which at 5*s.* each is 7205759403792·79 &c. *l.* and the double of this number will be the weight in *cwts.* then the value divided by 1000, and the weight by 2000, give each 7205759403·79 &c. for the number of horse or ship loads required.

† QUESTION 7. This question is to find three numbers, of which two shall be equal to each other, and each double of the third, and whose continual product shall be (29659·5) 340·5 less than 30000 : or, to find two numbers, the one double the other, and the less multiplied by the square of the greater shall produce 29659·5 : or, to find a number, the half of whose cube shall be 29659·5, : or its whole cube 59319 ; and consequently that number must be $\sqrt[3]{59319} = 39 =$ the age of each of the elder ; and consequently 19½ is that of the youngest.

Being eleven anſwers in whole numbers, which are all that can be found to ſell 56 quarts, at 22*d*. a quart.*

Solution of queſtion 9.

How to divide the grinding-ſtone	1ſt.	4·4508
Which ſev'n men grind down one by one?	2d.	4·8400
Look in the margin, and you'll find	3d.	5·3535
What each man for his part muſt grind.	4th.	6·0765
(I mean, what each man for his ſhare	5th.	7·2079
Muſt grind of the diameter:)	6th.	9·3935
Which being added all in one	7th.	22·6778
Do make up the firſt given ſum.†		60 Inches.

Solution of queſtion 10.

If the learn'd Ricciolus believed may be
When he tells you, reciprocal, pendulums be
To each others length, as their ſquares of vibration
Made up in the ſame time (without variation,)

Then

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* QUESTION 8. Putting x, y, and z for the number of quarts of the beſt, middle, and worſt ſort, reſpectively; then $x + y + z = 56$, and $32 x + 20 y + 16 z = 22 \times 56 = 1232$; hence $z = 3 x - 28$, and $y = 84 - 4 x$. Now x muſt be ſuch a whole number as will make both $3 x - 28$ and $(84 - 4 x$ or) $21 - x$ whole numbers; from the latter of theſe two equations, it appears that the greateſt value of x is 20 ; and from the former, that its leaſt value is 10 : ſo that x may be any number from 10 to 20 incluſive; and by ſubſtituting every number from 10 to 20 for x, in the two equations $z = 3 x - 28$, $y = 84 - 4 x$, we obtain theſe eleven anſwers in whole numbers ; viz.

$x = $ 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, quarts at 32*d*. each.
$y = $ 44, 40, 36, 32, 28, 24, 20, 16, 12, 8, 4, quarts at 20*d*. each.
$z = $ 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, quarts at 16*d*. each.

† QUESTION 9. This queſtion is to divide a circle, of 60 inches diameter, into 7 equal parts, or rings, bounded by concentric circles ; of which the ſolution will be thus.—The whole circle, and each inner circle, after the ſeveral preceding rings are ground off, muſt be to each other, by the queſtion, as the numbers 7, 6, 5, 4, 3, 2, 1 ; but circles are as the ſquares of their diameters ; therefore the diameters of thoſe circles will be to one another as $\sqrt{7}$, $\sqrt{6}$, $\sqrt{5}$, $\sqrt{4}$, $\sqrt{3}$, $\sqrt{2}$, $\sqrt{1}$: but the greateſt diameter is 60 or 60 $\sqrt{\frac{7}{7}}$; therefore, by proportioning, all the other diameters will come out thus, 60 $\sqrt{\frac{6}{7}}$, 60 $\sqrt{\frac{5}{7}}$, 60 $\sqrt{\frac{4}{7}}$, 60 $\sqrt{\frac{3}{7}}$, 60 $\sqrt{\frac{2}{7}}$, 60 $\sqrt{\frac{1}{7}}$: Now the laſt of theſe is the diameter of the laſt perſon's ſhare, and the difference between every two adjacent terms being taken, will give the double breadth of the rings, or the parts of the whole diameter to be ground off by the other perſons ; viz.

60

Then fifty two inches, fix cents, fomething o'er
Will anfwer this queftion: fo provide for fome more.
    i. e. 52·0630399162518510827r being the cube-root to
    20 Decimals.*   Every

$$60\sqrt{\tfrac{7}{7}} - 60\sqrt{\tfrac{6}{7}} = \frac{\sqrt{7} - \sqrt{6}}{\sqrt{7}} \times 60 = 4\text{·}450794 \quad \text{the 1ft}$$

perfon's fhare

$$60\sqrt{\tfrac{6}{7}} - 60\sqrt{\tfrac{5}{7}} = \frac{\sqrt{6} - \sqrt{5}}{\sqrt{7}} \times 60 = 4\text{·}839951 \quad \text{the 2d}$$

$$60\sqrt{\tfrac{5}{7}} - 60\sqrt{\tfrac{4}{7}} = \frac{\sqrt{5} - \sqrt{4}}{\sqrt{7}} \times 60 = 5\text{·}353518 \quad \text{the 3d}$$

$$60\sqrt{\tfrac{4}{7}} - 60\sqrt{\tfrac{3}{7}} = \frac{\sqrt{4} - \sqrt{3}}{\sqrt{7}} \times 60 = 6\text{·}076516 \quad \text{the 4th}$$

$$60\sqrt{\tfrac{3}{7}} - 60\sqrt{\tfrac{2}{7}} = \frac{\sqrt{3} - \sqrt{2}}{\sqrt{7}} \times 60 = 7\text{·}207871 \quad \text{the 5th}$$

$$60\sqrt{\tfrac{2}{7}} - 60\sqrt{\tfrac{1}{7}} = \frac{\sqrt{2} - \sqrt{1}}{\sqrt{7}} \times 60 = 9\text{·}393480 \quad \text{the 6th}$$

$$60\sqrt{\tfrac{1}{7}} - 60\sqrt{\tfrac{0}{7}} = \frac{1}{\sqrt{7}} \times 60 = 11\text{·}677870 \quad \text{the 7th}$$

the fum of them all is 60·000000 the
whole diameter.

The CONSTRUCTION
will be thus.—Divide the
radius *A B* of the given
circle into 7 equal parts;
and at the points of divi-
fion erect perpendiculars
meeting the circle, defcrib-
ed on the diameter *A B*,
in D, F, H, K, M, O;

then with the center *A*, and radiufes *A O*, *A M*, *A K*, &c. circles
being defcribed, the thing is done.—For, by the nature of the cir-
cle, the fquares of the chords or radiufes *A O*, *A M*, *A K*, &c.
are as the verfed fines *A N*, *A L*, *A I*, &c.
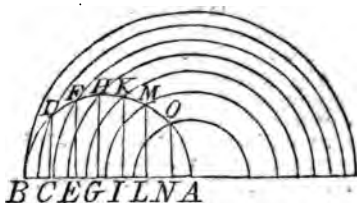
SCHOLIUM. It is evident that the above method of calculation
and conftruction will both hold true alfo when the fhares are un-
equal in any proportion; by ufing the refpective proportional num-
bers in the former, and dividing the radius *A B* in the fame propor-
tion in the latter.

    * QUESTION 10. Since the lengths of different pendulums are
to each other reciprocally as the fquares of their vibrations made in
the fame time; we fhall have, putting *x* for the length required,
x : 39·2 :: 60² = 3600 : *x x*; hence $x^3 = 3600 \times 39\text{·}2$, and
$= \sqrt[3]{3600 \times 39\text{·}2} = \sqrt[3]{141120} = 52\text{·}06304$ inches, nearly.

Every one of thefe queftions were anfwer'd by Mrs Mary and Mrs Anne Wright, before named; and by Mr Tho. Markham, of King's-lyn (who anfwer'd the 10th qu.) four of 'em were anfwer'd by Mr Fr. Walker, of Lyn-regis, Mr Hen. Beighton of Griff. Mr Amos Fifh. The 6th, 9th, and 10th, were anfwer'd by Mr John Richards, Mr Rob. Salter, of Topfham; and Mr Abr. Symmonds, Mr Hen. Carter, Mr John Bofwell, Mr John Mark, and Mr Rob. Whittle, anfwer'd one or more of them.

The eclipfes of this year.

The two great lights of heaven, the fun and moon, will each this year be twice eclipfed.   North.

The firft is an eclipfe of the moon upon the fecond day of february; being candlemas-day, betwixt the hours of ten and eleven at night, and, if the air be clear, will be vifible to us: near ten parts of the twelve of the moon's diameter will be obfcured, by the fha-dow of the earth, on the fouth part of her body, according to the type here in the margin.

East.   Weft.

South.
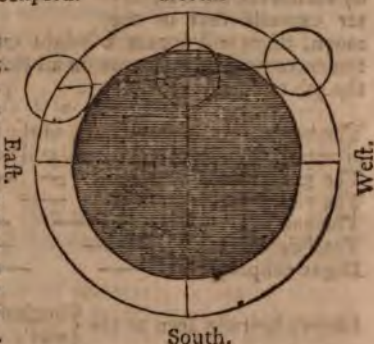
	h.	m.	s.
To the inhabitants of the city of Coventry the beginning of this eclipfe will be at	8	54	58 p. m.
The true oppofition is at	10	16	37
The middle of the greateft obfcuration at	10	21	41
The end of the eclipfe at	11	48	24
Total duration will be	2	53	26
The digits eclipfed	9	56	43 fouth.

m. s.

Latitude of the moon at the { beginning 38 48 } north defcen.
                              { end   29 19 }
                                                               The

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* This eclipfe was obferved by Mr H. Crefferner at Streatham, about 6 miles almoft directly fouth of London, with a very good 8 foot telefcope, the time by his clock being accurately corrected from Mr Flamftead's obfervations. He fays that, the time of the end, (which was what alone the want of a proper apparatus, and a fa-vourable fky, would give me leave accurately to determine) I found

The fecond eclipfe is of the fun, upon feb. 17, near 1 in the afternoon, and will (if the air be clear) appear to us in England, a confiderable eclipfe; for more than two third parts of the fun's body will be darkened, on the north part: (fee the type in the margin.) It will be a great and central eclipfe in divers parts of the world, but by reafon the fun's diameter exceeds that of the

moon, there will appear a bright circle of the body of the fun encompaffing the moon on all parts (as it did at Rome on the 9th of April, 1576.)

	h.	m.	s.
The begining of this eclipfe, to the inhabitants of the city of Coventry, will be at	11	12	17 mane.
The greateft obfcuration at — — —	0	42	58
The vifible conjunction at ———	0	45	11 p. m
The end at —— — —	2	10	18
Total duration is —— —	2	58	1
Digits eclipfed —— ——		8	8 36 north

	m.	s.
Moon's latitude feen at the { beginning	0	17 fouth } afcend.
{ end	16	57 north }

The third will be an eclipfe of the moon, on the 19th day of july, between 9 and 10 a clock in the morning, therefore not vifible to us: fhe will be 9 digits 13 min. darkened.

The laft is an eclipfe of the fun, on auguft 13, near 6 of the clock

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to be the fame (with but a very inconfiderable difference) which the calculation, according to Sir Ifaac Newton's admirable theory, promifed me to expect.

He then puts down the calculations at large, both according to Sir Ifaac's theory, and that of Mr Horrox; the refult of which is that he finds

	h.	m.	s.
The end of the eclipfe by the moon's place from } Sir Ifaac Newton's theory — —	12	2	0
The end by Horrox's theory — — — —	12	11	8
The end by obfervation — — —	12	1	30

The error therefore of Sir Ifaac's theory is, by this obfervation, but half a minute, or none; of Horrox's fyftem, nine minutes and half.

clock in the afternoon: and though the fun be then, to us in
Great Britain, an hour high, yet the moon's fouth latitude
being great, and being increafed by her fouth parallax, doth
deprefs her too low, as to interpofe between the fun and us,
or indeed of any part of Europe. But in the fouthern parts,
it will be both total and central, and formidable to behold
and in the latitude of 6 deg. 56 min. fouth, and longitude 138
deg. 3 min. weft from Coventry. This eclipfe begins at fun-
rifing, in lat. 30 deg. 13 min. S. and long. 151 deg. 54 min.
weft from Coventry he will be centrally eclipfed at fun-rifing.
In lat. 41 deg. 14 min f. and long. 105 deg. 59 w. from Coven-
try, he will be centrally eclipfed in the nonagefim. deg. in
76 54 f. and long. 64-57 w. from Coventry, he will be cen-
trally eclipfed at fun fetting: and in lat. 57 26 f. and long.
148 w. from Coventry the eclipfe ends at fun fetting.

Some geographical paradoxes propofed to the ingenious, to be folved againft next year.

1. THERE are two remarkable places in the globe of the
earth, in which there is only one day and one night
throughout the whole year.

2. There are alfo fome places on the earth, in which it is
neither day nor night at a certain time of the year, for the
fpace of 24 hours.

3. There is a certain place of the earth, at which, if two
men fhould chance to meet, one would ftand upright upon
the foles of the other's feet, and neither of them fhould feel
the other's weight, and yet both fhould retain their natural
pofture.

4. There is a certain place of the earth, where a fire be-
ing made, neither flame nor fmoke would afcend, but move
circularly about the fire. Moreover, if in that place one
fhould fix a fmooth or plain table without any ledges what-
foever, and pour thereon a large quantity of water, not one
drop thereof could run over the faid table, but would raife it
felf up in a large heap.

5. There are three remarkable places on the continent of
Europe, that lie under three different meridians, and yet all
agree both in longitude and latitude,

6. There is a certain ifland in the Ægæon fea, upon which,
if two children were brought forth at the fame inftant of
time, and living together for feveral years, fhould both ex-
pire on the fame day, yea, at the fame hour and minute of
that day, yet the life of the one would furpafs the life of the
other by divers months]

Now

New Questions.

I Question 11.

A man being afked what cafh he'd in ftore ?
Reply'd, I have three forts of coin, and no more.
I have fix-pences, fhillings, half crowns; now to fhew
The whole fum that I have, by this means you may know:
If the fhillings and fix-pences both you do join
In one fum, they will make juft four hundred and nine :
If the fhillings and half crowns together you count,
The number of both you will find to amount
To one thoufand, two hundred, fifty and four,
(Which clears up the cafe fomething more than before.)
But if you from the half crowns and fix-pences take
Four times ten, aud twice one, the remainder will make
One thoufand, one hundred and three. Now from hence
You may tell what I have in pounds, fhillings and pence.

II Question 12.

A gentleman was by agreement to pay
   One thoufand pounds juft, and no more;
And he had none other but two forts of gold,
   Which were * guineas and † luidores.   * *Of* 2 *s.* 6*d.*
How many of each muft he give to defray   † *Of* 17 *s.*
His faid debt, and how many ways might he pay
This faid fum by thefe two only coyns, tell me, pray?

III Question 13.

A farmer with a plowman doth agree.
That thirty days his fervant he fhould be.
Each day he wrought, the farmer is to pay
Him fixteen pence ; but when he is away,
Five groats he is for each day to abate :
The time expir'd, they their accompts do ftate,
Whereby the mafter nothing is to give,
Nor has the fervant any to receive.
How many days he wrought I do demand,
And how many he play'd I'd underftand?

IV Question 14.

   In the midft of a meadow well ftored with grafs,
I took juft an acre to tether my horfe :
How long muft the cord be, that feeding all round,
He mayn't graze lefs nor more than his acre of ground?

V Question 15.

   A country fpark addreft a charming fhe,
   In whom all lovely features did agree :
   But he not fkill'd i'th' art (you may prefage,)
   Was too folicitous to know her age.

The

The lady fmil'd at this prepoft'rous rule
Of courtfhip: but to fatisfy the fool,
Made him this anfwer with a gen'rous air
(A lofty charm peculiar to the fair,)
" My age is that, if multiply'd by three,
" And two fev'nths of that product trebbl'd be,
" The fquare-root of two ninths of that is four:
" And now farewel——I'll never fee you more.
" Your fond impertinence has caus'd this rage:
" 'Tis clownifh fure to afk a woman's age.
So you're defir'd t' affift him, or perchance
The fpark muft ftill remain in ignorance.

Queftion 16, *by way of letter.*

London, May the firft, 17 hundred and 9.

Dear friend,
I make bold for to fend you a line
T' inform you what hapt to me this very day:
As I pafs'd with fome friends thro' cheapfide, in our way
We were viewing Bow-fteeple, fays a fpark that ftood by,
Can you tell, fir, by art, how many feet that is high?
" I'll lay you I can, fir, a piece to be fpent:
" 'Tis done, quoth the fpark: I reply'd, " I'm content.
We laid down our money. The fun fhining plain,
I meafur'd the fhadow, which I found to contain
Two hundred fifty three feet, half a quarter,
And the clock juft ftruck twelve as I finifh'd the matter.
Now (good fir) inform me, how high is the fteeple?
For you can't beat it into my head with a beetle
How it is to be done:——Were the wager to find, Sir,
A pritty plump girl, or a good glafs of wine, fir,
I think I could do it as well as the beft;
But thefe crabbed hard numbers I ne'er could digeft.
Fail me not in this pinch, fir, whatever you do,
If you fhould, my dear money away I fhall throw:
Befides, all my friends, fir, will laugh at me too.

1711.

Anfwers to the geographical paradoxes propounded in the laft year's diary.

Solution of Paradox 1.

The places lie under the two poles,

Solution of Paradox 2.

The places muft be 90 degrees from the fun when he is in or near the tropicks. Thus, if the fun is in the tropick of capricorn, the places then will be under the artic-circle, or rather 15 minutes (being the femediameter of the fun) more north, for then it is day, becaufe the fun is below the horizon: nor is it night, becaufe by the refraction of the atmofphere the fun to the inhabitants of that place will feem to be really rifen. The reafon of fuch refraction I gave you in my diary of 1709.

Solution of Paradox 3 and 4.

Is the center of the earth.

Solution of Paradox 5.

By Mr Robert Wilfon, to this effect, viz. Divers geographers begin their firft meridians at divers places. Thus Ptolemy at Cape Verd, (formerly one of the fortunate iflands.) Mercator, at St Michael's in the Azores. Blaew, at Teneriff in the canary-iflands, &c. Now if you take (under the fame lat.) 3 places (fuppofe 10 degrees) from each of thefe firft meridians, they agree all in lat. and alfo in long. from thofe 3 refpective places, and yet lie under 3 different meridians, in refpect of the globe.

Solution of Paradox 6.

Mrs. Lydia Fifher anfwers it thus: if one of the children fails directly eaft, and the other directly weft, when they encompofs the globe of the earth once (which is now eafily done in a year) there will be two days difference in their age. And in 40 years thus failing, the one would be 80 days older than the other.

Mr Mark Moyle anfwers it thus: fuppofe the one lives within the artick Circle (where no day exceeds 24 hours) and the other goes and lives in the parallel of lat. (fuppofe of 73) deg. 20 min. where the day is 3 months long. and then returns, and both die; the one will be three months older than the other——Thefe were anfwer'd alfo by Mr *Leadbetter, Mr.* John Senhoufe, Mr. Will. Davenport.

Solu-

Solutions to the last year's questions.

* I. *Question* 11. *answered by* Mr. Tho. Gosling.

The answer will be, as sure as you're alive,
Of half crowns nine hundred ninety and five,
Of shillings two hundred fifty and nine,
Of sixpences sev'n score and ten (very fine:)
Which added together, the whole comes from thence
To one hundred forty one pounds, eighteen pence.

i. e. 995 half crowns, 259 shillings, 150 sixpences, in all
141 l. 1 s. 6 d.

† II. *Question* 12. *answered by* Mr. John Boswel.

To pay the debt as you propose,
There are no other way than those
Which here below doth plain appear,
In number sev'n and twenty are.

Guineas—32. 66. 100. 134, &c. by adding always 34.
Lewidores— 1136. 1093. 1050. 1007, &c. by subtr. always 43
will give 27 answers, each two sums making 1000 l.

Question

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* I. QUESTION 11. *solved.*

The meaning of this question is that the sum of the shillings and sixpences is 409, the sum of the shillings and half-crowns is 1254, and the sum of the sixpences and half-crowns 1145; to find the number of each. That is, having given the sums of every two of three numbers, to find the numbers.

Put $x =$ the number of sixpences, $y =$ the shillings, and $z =$ the half-crowns. Then, by the question, $x + y = 409$, $y + z$, $= 1254$, and $x + z = 1145$. The sum of the first and third, is $2x + y + z = 1554$, from which taking the second, we have $2x = 300$; hence $x = 150$, $y = 409 - x = 259$, and $z = 1145 - x = 995$. And the sum of these all together amounts to $141 l. 1 s. 6 d.$

† II. QUESTION 12. *solved.*

Put x for the number of guineas, and y for that of the louis-d'ors. Then will $43x + 34y$ be $= (1000 \times 40 =) 40000$; hence $y = \frac{40000 - 43x}{34} =$ (by dividing) $1176 - x - \frac{9x - 16}{34}$; consequently $\frac{9x - 16}{34} =$ a whole number, as also 4 times the same, viz, $\frac{36x - 64}{34} = \frac{18x - 32}{17} =$ (by dividing) $x - 2 + \frac{x + 2}{17}$; hence $\frac{x + 2}{17} =$ a whole number $= p$; then $x = 17p - 2$.

Mathem.   G   This

* III. *Queſtion* 13. *anſwered.*

That lazy drone, who ſquander'd away,
Thirteen days, and one third, in ſleep and play,
In thirty days (for all he nothing got)
Deſerv'd to have his bones broke, for an idle ſot.

i. e. He work'd 16 days 8 hours, and play'd 13 days 4 hours.

† IV. *Queſtion* 14. *anſwered by Mr.* Nat. Browne.

If you be diſpos'd, ſir, to tether your horſe
In a meadow that's very well ſtored with graſs,
That juſt he may graze up an acre of ground,
The length of the cord may hereunder be found.
　　　　　viz. 39 Yards. 2507375.

‡ V. *Queſtion* 15. *anſwered by Mr.* John Ford.

Young maids oft ſpeak their minds with words ſo dark,
That leaves a doubtful meaning on their ſpark;
Elſe ſhe might ſurely without words ſo plenty,
As well have ſaid her age was eight and twenty.

　　　　　　　　　　　　　　　　　　Queſtion

This written for it in the expreſſion $y = \frac{40000 - 43x}{34}$, gives y.

$= 1179 - 21\frac{1}{2}p$; conſequently $p =$ any even number $=$ (ſuppoſe)
$2n$; then $y = 1179 - 43n$, and $x = 34n - 2$; where n is any
integer number.

Taking ſucceſſively the numbers 1, 2, 3, 4, &c. for n, we have

$x = \quad 32, \quad 66, \quad 100, \quad 134, \quad 168, \quad 202, \quad 236, \quad 270, \quad 304,$ &c.
$y = 1136, \quad 1093, \quad 1050, \quad 1007, \quad 964, \quad 921, \quad 878, \quad 835, \quad 792,$ &c.

* III. QUESTION 13. *ſolved.* Since the two products of each
number of days by their reſpective prices are equal to each other, it
follows that the ſaid number of days will be reciprocally as the
prices; but the prices are as 20 to 16, or as 5 to 4, whoſe ſum is 9,
and the whole number of days is 30; whence 9 : 30 or as 3 : 10

:: $\begin{cases} 5 : 16\frac{2}{3} \text{ days worked.} \\ 4 : 13\frac{1}{3} \text{ days idled.} \end{cases}$

† IV. QUESTION 14. *ſolved.* The number of ſquare yards in
an arce being 4840, and a circle being equal to 3·14159 &c. drawn

into the ſquare of the radius; therefore $\frac{4840}{3·14159 \text{ &c.}} =$ the ſquare
of the radius, and conſequently the radius itſelf or length of the

chord will be $\sqrt{\dfrac{4840}{3·14159 \text{ &c.}}} = 39·25073$ yards.

‡ V. QUESTION 15. *ſolved.* Put x for the lady's age. Then,

by the queſtion, $\sqrt{3x \times \dfrac{2}{7} \times 3 \times \dfrac{2}{9}} = \sqrt{\dfrac{36x}{63}} = 4$; hence

$x = \dfrac{16 \times 63}{36} = \dfrac{16 \times 7}{4} = 4 \times 7 = 28.$

* *Queſtion* 16. *being the Prize Queſtion, anſwered by Mrs.*
Mary Wright, *to whom I preſented the* 12 *diaries, accord_*
ing to my promiſe. I will give it you in her own words :

May 1, 1709.

	o	"	'
Sun's longitude, from its ingreſs into aries —	51	28	0
Oblique angle of the ecliptick and equator —	23	29	0
Thence the declination that day — —	18	9	45
Conſequently its merid. altitude in lat. 51° 32'.	56	37	45
The complement thereof to 90 is — —	33	22	15

Then as the ſine of the angle 33°. 22'. 15".
To the baſe 253. 125 feet,
So is the ſine of the angle 56. 37. 45.
To the perpendicular 384. 307 feet the height of the ſteeple.

☞ Note, The true heighth of Bow ſteeple is 225 feet,
for which at firſt I had proportioned the length of the ſhadow,
but upon ſecond thoughts I alter'd it, for fear ſome, who had
read its heighth in hiſtory, ſhould claim the reward, without
having art enough to inveſtigate it by trigonometry.

The anſwer to the perſon that ſent the 16th queſtion.

Sir, Yours I received, and finding you are
    A pleaſant companion, and kind to the fair,
    I thought myſelf bound to aſſiſt you in this ;
    When to London I come you won't take it amiſs,
    If I give you the trouble to ſhew me your ſkill
    In chooſing a bottle, or a fair one that will.
To ſave then you coin, and prevent your friends laughter, ⎫
Three hundred eighty four feet and a quarter   ⎬
Is the height of the ſteeple, within a ſmall matter. ⎭

I received divers other anſwers in verſe, from divers other
perſons, but have not yet room to repeat them.

The

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* VI. PRIZE QUESTION 16. *ſolved.*

This ſolution, at length, will be thus :
The ſun's longitude being ſuppoſed 51° 28', and the angle made
by the equator and ecliptic 23° 29' ; by right-angled ſpherical tri-
angles, as radius : ſine of 51° 28' :: ſine 23° 29' : ſine 18° 9' 45"
the declination for the time; to which adding 38° 28' the com-
plement of the latitude, there reſults 56° 37' 45" for the meridian
altitude that day. Then, by right-angled plane triangles, the
height of the ſteeple will be found by Mrs. Wright's proportion
above, or rather thus, as radius : tang. 56° 37' 45" :: 253$\frac{1}{8}$: 384·3t
the ſteeple's height.

The eclipfes of this year 1711.

Six times this year will the two great lights of heaven be eclipfed, namely four times the fun, and twice the moon.

The firft is of the fun, on the 7th of january, 3 quarters of an hour after 9 at night; and, tho' invifible to us, about 3 deg. eaftward in longitude from Coventry (where it is greateft) the fun will fet about 3 digits eclipfed, on the fouth fide of it.

The fecond is of the moon, a great and total eclipfe on 23d of january, near noon, and fo invifible to us; but will be vifible near the meridian of our antipodes. It begins at Coventry at 27 min. 29 fec. after 10 in the morning; the im-merfion is at 26 min. 30 fec. after 11; the middle at 13 min. 10 fec. afternoon; the true oppofition at 14 min. 24 fec. after-noon; the emerfion at 59 min. 51 fec. afternoon: the end at 58 min. 52 fec. after 1. The total duration 3 hours 31 min. 23 fec. digits eclipfed 19 and near a quarter.

The third is a fmall eclipfe of the fun, on the 6th of fe-bruary at 1 ho. 11 min. 56 fec. in the afternoon, but cannot be feen by reafon of the great north latitude of the moon, except under the artick circle, where it is moft confpicuous, and about 78 deg. weftward in long. from Coventry; at fun-rifing, the fouth limb of the moon will touch the northern limb of the fun a little more than a quarter of a digit, or the 48th part of the fun's diameter, and therefore will hardly be perceptible.

The fourth will be an eclipfe of the fun, on wednefday the 4th of july, near 7 in the afternoon; and, if the air be clear, two third parts of the fun's diameter will be feen to be dark-ened on the north fide.

	h. m. s	
The beginning is at	7 3 46	
The vifible conjunction	7 53 51	p.m.
The greateft obfcuration	7 55 52	
The end	8 45 40	
The duration	1 41 54	
The digits eclipfed	8 35 40	
Moon's latitude feen at the { Beginning	12 33 } Nor.	
End	4 14 } Defc.	

This eclipfe, where grea-teft, can be but nine digits and an half, and that at fun-fetting under the artick circle, and longitude about 48 deg. eaft from us.

The

The fifth is a total eclipse of the moon on July 18, at near 6 in the afternoon, but not visible to us, because the eclipse ends 10 min. before the moon rises. The beginning is at 4 ho. 6 min. 34 sec. after noon. Immersion at 5 h. 7 m. 37 s. Middle at 5 h. 51 m. 26 s. True opposition at 5 h. 53 m. 24 s. Emersion at 6 h. 35 m. 15 s. The end at 7 h. 36 m. 18 s. Duration 3 h. 29 m. 44 s. Digits eclipsed 17 and an half.

The last is of the sun on the 28th of December at 9 h. 39 m. 53 s. in the morning, but by reason of the moon's south lat. augmented by her south parallax, it cannot be seen by us, altho' the sun is above the horizon, but will be both total and central in the southern parts of the world.

Two geographical questions proposed against next year.

Question 1.

In what degree of latitude
  Does that soft female dwell,
Who upon certain days might view,
  If she observeth well,
The morning sun on th' self same point
  Of compass twice to be,
Likewise his evening azimuth
  Twice in the same degree.
Tell me sweet english ladies, for you are
Than her more charming far, and far more fair.

Question 2.

In the Atlantick ocean from our shore
Distant five hundred leagues, or little more,
Lies the canary isles, blest with good air,
Sweet whistling birds, rich wines beyond compare.
A mountain, the world's wonder's situate there,
One of the highest in this earthly sphere:
By us 'tis call'd the teneriffa's pike;
Whose lofty head i'th' atmosphere's so high,
That it surmounts all grosser clouds o'th' sky.
Three degrees and an half, you may it ken,
Or, (what's the same) two hundred miles and ten;
For the refraction angle, you may make
Allowance, (what is thought but meet to take;)
Thirty five minutes just, of a degree.
Now I demand what heighth the pike must be?

New Arithmetical Questions.

I. *Question* 17.

I happen'd one ev'ning with a tinker to fit,
Whofe tongue ran a great deal too faft for his wit:
He talk'd of his art with abundance of mettle;
So I afk'd him to make me a flat-bottom kettle,
That the top and the bottom diameters be
In juft fuch proportion as five is to three:
Twelve inches the depth I would have, and no more,
And to hold in ale gallons feven lefs than a fcore.
He promis'd to do't, and to work he ftrait went;
But when he had done it, he found it too fcant.
He alter'd it then, and too big he had made it,
And when it held right, the diameters fail'd it:
So that making't fo often, too big, or too little,
The tinker at laft had quite fpoiled the kettle:
Yet he vows he will bring his faid purpofe to pafs,
Or he'll utterly fpoil ev'ry ounce of his brafs.
To prevent him from ruin, I pray help him out,
The diameter's length elfe he'll never find out.

II. *Question* 18, *by* Mrs. Lydia Fifher.

What two fums are thofe, can any fuppofe,
   If added together they muft
Make twelve-pence, be fure, and nine halfpence more,
   (Or fixteen-pence-halfpenny juft?)
But if by divifion you make a decifion,
   And the greater by th' lefler divide;
In the quotient will reft fev'n and twenty pence juft:
   Come, ladies, this riddle decide.
And to find out thefe numbers without any blunders,
   Pray tell me what courfe you will take:
And if you can do it, and to the world fhew it,
   Amends, when I meet you, I'll make.

III. *Question* 19.

Pray try your fkill two numbers for to find,
Whofe fum, when added, will be juft one fev'nth; ($\frac{1}{7}$)
And if together they be multiply'd,
Their product's four eight hundred forty fev'nths. ($\frac{4}{847}$)
Fractions are called numbers here, you fee,
And your true anfwer will two fractions be.

IV. *Queſtion* 20, *by Mr.* William Hawney.

A famous general having ſerv'd his king
Long time in wars, and had victorious been;
For which his ſervice (with a pleaſant ſmile)
Aſk'd of his king one farthing for each file
Of ten men in a file, which he could then
Make with a body of one hundred men.

The king conſidering his brave actions paſt,
And ſeeming modeſty of his requeſt,
Gave his conſent:———To what will it amount.
In ſterling money? Take your pen and count.

V. *Queſtion* 21. *by Mr.* Gideon Coſier.

A gentleman, as he did ride,
Near to a pleaſant common ſide,
Some ſhepherdeſſes chanc'd to meet,
Driving their flocks; whom he did greet.
God ſpeed you well; and may you be
As happy as you're fair, (quoth he:)
Proſper your flocks, and may they thrive;
Tell me how many ſheep you drive?
One of the damſels ſtreight reply'd,
Sir, you ſhall ſoon be ſatisfy'd,
For if the flock we ſhould divide
Among us equally, each ſhare
Is twice the number we maids are:
But if for one of us you do
Count one ſheep, for the next count two,
For the third four, for the fourth eight,
So doubling at each maid aright,
At the laſt maid the ſum would be
As many as the ſheep you ſee.

Queſt. 22. *by Mr.* Amos Fiſh.

From Biſcay we ſail'd with a very fair gale,
Our courſe was full north, and we ſpread ev'ry ſail;
For the weather was curious, unclouded the ſun,
And for ſeveral days we with pleaſure did run.
But the wind coming croſs, we concluded it beſt
To alter our courſe; ſo we ſteered full weſt,
Till our diff'rence o' longitude was one degree more
Than the latitude's diff'rence we had ſailed before.

Now, pray ſir, reſolve me how far we have run,
And how far 'tis from Biſcay from whence we begun.
All the help I can give you tow'rds finding it out,
Is, that the neareſt diſtance when we tack't about,

To a ftreight line, if drawn from the place where we be ⎫
To Bifcay, (accounting 60 miles a degree)   ⎬
Is fev'n fcore and ten miles, as fure as can be.   ⎭

The Prize Queftion for 1711, *that whoever firft anfwers
        fhall have a dozen diaries.*

When tir'd with bus'nefs, or perplex'd with care,
Or minded am to breathe in fragrant air,
I to my lonefome garden ftrait retire,
To foothe thofe cares, and nature's works admire.
Here rows of charming greens delight the eye,
And here a chryftal ftream glides gently by:
There lovely flow'rs adorn their earthy bed,
Blended with curious dyes of white and red:
But when one lovelier than the reft I find,
It brings the charming fex into my mind.
    For of all beauties in the world we know,
        A beauteous woman does the reft out-do.
    Within this place I have two lofty firs,
Which above all my trees my mind prefers.
Upright, and ftreight, and taper to the top,
On each of which a gilded ball I've put.
Between each tree, when meafur'd on the ground,
In a ftreight line, juft fix-fcore feet I've found.
The higher tree one hundred feet contain,
Four-fcore the lower (both ftand on a plain.)
Between my trees a fountain I would place,
(The better ftill my garden for to grace)
But fo, that from the ball o'th' top each tree
Should to my fount of equal diftance be.
    And from this fount a walk I would have made,
And with fuch nicety of art be laid,
That as along the fame I near or far do move,
I'd equal diftant be from each o'th' balls above.
    At this walk's end a houfe of pleafure I
Would have fo plac'd by art, that when I lie
Upon my couch, to meditate, or read,
Or fometimes fleep to eafe my aking head,
From ball to ball, and from each ball to me,
May equal diftance from each other be.
    Come, artifts, now revolve within your mind
How thefe things muft be done; and then to find
How far my houfe of pleafure plac'd muft be
From th' fount, and from the bottom of each tree?

This queftion, and queft. 17. of the tinker, &c. of this
diary: alfo the queftions laft year of the *Lady's Age*, and
Bow Steeple, are good patterns how an arithmetical quef-
                                                    tion

tion fhould be compofed: namely, to cloathe it with fuch
delightful circumftances, as fhould egg us on to the folving
the moft ufeful part. To heighten delight, whet the ima-
gination, and fharpen invention all at once, to enlarge
the capacity of the mind, and raife our pleafure to the higheft
pitch it is capable of; and I hope the poetical artift will in
time to come fend me fome fuch queftions as thefe.

1712.

Anfwers to the Geographical Paradoxes pro-
pounded in the laft year's diary.

Paradox 1, anfwered by Mr. Hutchinfon.

Between the tropicks and the line,
    That female I can fhew,
That twice the fun on the fame point,
    I'th' morn, and ev'n, may view.
And tho' our englifh ladies charms
    Excel her far by day,
In filent Nox's foft embrace
    She's no lefs charms than they.

* Paradox 2, explained by Mr. Nat. Brown.

That famous mountain Teneriff you call,
Whofe towring pike o'er-looks this earthly ball,
Four miles and quarter is, and fomething higher;
A height prodigious that all men admire. (4'281)

Solutions

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* The folution of this paradox is only an eafy example in plane
trigonometry, in which the radius of the earth is one leg of a right-
angled triangle, the fum of the faid radius and height of the moun-
tain is the hypothenufe, and the angle included by them is equal to
the degrees in the arc of the vifible diftance. Now taking the re-
fraction 35' from 3° 30' leaves 2° 55' for the faid angle, and
11600 ÷ 2 × 3'14159 &c. = 3437'747 is the earth's radius in geo-
graphical miles; then as the cof. of 2° 55' : rad. or fine of 90° ::
3437'747 : 3442'206; from which taking 3437'747, we obtain 4'459
miles for the mountain's height; which is a little different from the
anfwer above given.

Solutions to the laſt year's Queſtions.

I. *Queſtion* 17, *anſwered by Mr.* Rich. Parker.*

Before the laſt chriſtmas there came to my houſe,
A jolly fine tinker, who ſeem'd very chouſe;
I aſkt him, If ſtore of good work he had got:
He reply'd, that he had; but that he like a ſot,
Undertook t'other day for a critical aſs,
" To make him a flat-bottom'd kettle of braſs,
" Whoſe wideneſs at top and at bottom ſhould be
" In the ſame proportion as five is to three,
" The depth it ſhould juſtly twelve inches contain,
" And that it ſhould hold in ale gallons thirteen.
That he try'd many ways for to bring it about,
And yet after all he could make nothing out:
Which at length it had made him ſo wondrous poor,
That work for a tinker he crys at each door;
Who had braſs, and had money enough juſt before.
  The tinker's ſad ſtory did make my heart ake,
So I gave him the meaſure each wideneſs would take,
(As hereunder you'll find) for his kettle to make.
  With a great deal of joy then away went my friend,
Crying, Have ye any work for a tinker to mend?
Any boles, any bellows, any pots made of mettle;
But he ne'er could endure for to hear of a kettle.

<div align="center">

Leſſer diameter   14˙6390238.
Greater diameter 24˙398373.

</div>

The ingenious Mrs. *Barbara Sidway*, in anſwer to this
queſtion, propoſeth another very pretty one at the ſame
time.

Well, bonny brave tinker, to ſave thee from ruin,
The kind britiſh laſſes are active and doing;
Becauſe that thou art a brave fellow of mettle,
Take here the diameters both of thy kettle;
One's twenty-four inches, four-tenths, very near,
T'other fourteen, and ſixty-four cents doth appear.

<div align="right">

Queſtion

</div>

<div align="center">

* I. Q U E S T I O N 17. *ſolved.*

</div>

Putting $5z$ and $3z$ for the top and bottom diameters, by page
525 Menſuration, we ſhall have ($3 \times 64zz + 4zz$ or) $196zz$
$\times 12 \times ˙00023209 = 13$: hence $z = \sqrt{\dfrac{13}{196 \times 12 \times ˙00023209}}$
$= 4˙880057$; conſequently $3z = 14˙640171$, and $5z = 24˙400285$,
the two diameters required.

Queſtion to the tinker, or his friend.

But now if it was to hold as much again,
And carefully lengthened at its biggeſt end,
(The whole being a fruſtum cone) I would fain know
How much is the depth of that added below?

† II. *Queſtion* 18. *anſwered.*

The firſt of your numbers, without any blunders
  I find to be one that is mixt,
Fifteen the whole part, according to art,
  And juſt fifty one—fifty ſixths. $(15\frac{51}{56})$
Then, dear madam Fiſher, for I do not miſs here,
  Denominate ſeven times eight; $(\frac{33}{56})$
Thrice eleven of theſe, you may take if you pleaſe,
  So your queſtion is anſwer'd compleat.

                                        Queſtion

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* *Anſwer to the queſtion to the tinker, or his friend.*

If $5a$ and $3a$ be the diameters of the firſt or given fruſt-m, whoſe
altitude is 12, and z the altitude of the fruſtum to be added:
Then, by ſimilar triangles, &c. $\frac{1}{6}z + 5a =$ the greater diameter
of the part added; and ſince the two contents are equal, we ſhall
have $\overline{\frac{1}{6}az + 5a}|^2 + \frac{1}{6}az + 5a \times 5a + 25a^2 \times z =$
$\overline{25aa + 15aa + 9aa} \times 12$, or $\overline{\frac{1}{6}z + 5}|^2 + \frac{1}{6}z + 5 \times 5 + 25 \times z$
$= 49 \times 12 = 588$, or $z^3 + 90z^2 + 2700z = 21168$. Hence
$z = 6\cdot3847619 =$ the height of the part to be added.

† II. QUESTION 18. *ſolved.*

Put z for the leſs number: then, by the queſtion, either $16\frac{1}{2} - z$
or $27z$ will expreſs the greater: hence $27z = 16\frac{1}{2} - z$, or $28z =$
$\frac{33}{2}$; then $z = \frac{33}{56} =$ the leſs number, and conſequently $16\frac{1}{2} - \frac{33}{56}$
$= 15\frac{51}{56} =$ the greater.

OTHERWISE.

Let $x =$ the leſs number; then $27x =$ the greater, and $28x =$
$16\frac{1}{2} = \frac{33}{2}$; hence the reſt will be as above.

OTHERWISE.

Since, as above, the numbers are in proportion as 27 to 1, and

their ſum $= 16\frac{1}{2}$: hence as $28 : 16\frac{1}{2} :: \begin{cases} 1 : \frac{33}{56} = \text{the leſs number.} \\ 27 : 15\frac{51}{56} = \text{the greater.} \end{cases}$

* III. *Queſtion* 19, *anſwered by* J. R. S.

   Theſe fractions I have ſet down below,
'The anſwer to your nineteenth queſtion ſhow.

$$\frac{1}{11} \qquad\qquad \frac{4}{77}$$

† IV. *Queſtion* 20, *anſwered by* Mrs. Sidway.

   Great heroes deeds no poets lines expreſs,
Nor worthy actions recompens'd in verſe;
Numbers alone their merits muſt recount,
See here below how vaſt the ſums amount.

$$\frac{91}{1} \times \frac{92}{2} \times \frac{93}{3} \times \frac{94}{4} \times \frac{95}{5} \times \frac{96}{6} \times \frac{97}{7} \times \frac{98}{8} \times \frac{99}{9} \times$$

$$\frac{100}{10} = 17310309456440 \text{ farth.} = 18031572350 l. 9 s. 2 d.$$

V. *Queſt.* 21, *anſwered by* Mr. Alexander Weedon.

   Oh happy man! what charms did you invite,
When ſuch a knot of fair ones came in ſight;
It muſt enlarge and elevate your ſoul,
And make it boundleſs too without controul.
To ſee their lovely looks, their charming mein,
Their modeſt bluſhes, as they grac'd the green;
Their ſhape ſo raviſhing, that Cupid's dart
You needs muſt feel quite through and through your heart,
                       When

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* III. QUESTION 19. *ſolved.*

   Let $\frac{1}{14} + z$ and $\frac{1}{14} - z$ expreſs the two numbers; then

$\overline{\frac{1}{14} + z} \times \overline{\frac{1}{14} - z} = \frac{1}{196} - zz = \frac{4}{847}$; hence $z =$

$\sqrt{\frac{1}{196} - \frac{4}{847}} = \frac{3}{154}$; conſequently $\frac{1}{14} + \frac{3}{154} = \frac{1}{11} =$ the

greater number, and $\frac{1}{14} - \frac{3}{154} = \frac{4}{77} =$ the leſs number..

† IV. QUESTION 20. *ſolved.*

   The number of variations of 10 in 100 are $\frac{100}{10} \times \frac{99}{9} \times \frac{98}{8} \times$

$\frac{97}{7} \times \frac{96}{6} \times \frac{95}{5} \times \frac{94}{4} \times \frac{93}{3} \times \frac{92}{2} \times \frac{91}{1} = 17310309456440 =$
the number of farthings $= 18031572350 l. 9 s. 2 d. =$ the ſum de-
manded.

When eight fair ſhepherdeſſes to your view,   (8 *maids*)
Were altogether met beholding you.
Who came to feed their harmleſs flocks of ſheep,
Which daily they did on the common keep;
The number juſt one hundred twenty eight,   (128 *ſheep*)
On which they did ſo diligently wait.
Which numbers both do very well agree:
The queſtion's ſolv'd as plainly you may ſee.*

Mrs. Barbara Sidway, *to Mr.* Gideon Croſier, *the propoſer.*

The ſheep were one hundred twenty eight,
The virgins, twice four, and a glorious ſight.
But honeſt maſter *Gideon Croſier,*
Upon my word you ſent a poſer:
Had not the number eaſy been, Sir,
You might have whiſtled for an anſwer.
For do but in your mind revolve,
Queſtions ſuch as this to ſolve,
This ſame equation muſt reduce,
As underneath you may peruſe,
Where (*a*) the vowel, is unknown, Sir,
Reduce it, and call me your own, Sir.

$$r^a = r\,d\,a\,a. \quad \text{Or,} \quad r^{a-1} = d\,a\,a.$$

VI. *Queſtion* 22, *anſwered by the ſame.*

Sail'd north ——————— 188·256 miles
Sail'd weſt ——————— 248·256
Diſtance run ——————— 436·512
From Biſcay to the ſhip's place 311·555

Suppoſe

If *z* be put to denote the number of maids; then, by the queſtion, $z \times 2z = 2zz$ will denote the number of the ſheep, and $2zz = 2^{z-1}$; hence, multiplying by 2, we have $4zz = 2^z$; and, by extracting the root, $2z = 2^{\frac{1}{2}z}$: From this equation, by trials, we eaſily find $z = 8 =$ the number of maids; and then $2zz = 128$ the number of ſheep.

When the quantity of *z* is an integer number, it is beſt found by trials as above. But if it be ſome infinite decimal, put the above equation into logarithms, and we have $\frac{1}{2}z \times \log. 2 = \log. 2 + \log. z$, or $\cdot150515\,z - Z = \cdot301030$, putting $Z = \log.$ of *z*; then find the value of *z* by double poſition or the method of trial-and-error.

Mathem.   H

Suppofe it plain failing, the anfwer you fee,
But if by Mercator, pray, what would it be?
That handfome tarpawlin I almoft durft wed,
That has the true method thereof in his head.*

*Anfwer to the Prize Queftion, which was firft anfwered
by Mr.* Henry Beighton, *and foon after by Mrs.* Anna
Wright, *Mr.* Ford, *Salt-officer of Middlewich, and di-
vers others.*

I lately heard your curious garden nam'd,
For its exactnefs all o'er England fam'd :

Your

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* VI. Q U E S T I O N 22. *folved.*

From the right angle B let fall the perpen-
dicular BD : If AB reprefent the diftance
failed north, and BC the diftance weft; then
will AC reprefent the diftance between *Bifcay*
and the place arrived at, and BD 150 miles.
Now by right-angled triangles we have
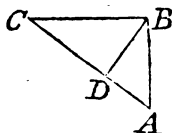
$$AC^2 = CB^2 + BA^2,$$

and $2AC \times BD = 2CB \times BA;$

hence, fubtracting the fecond equation from the firft, we have
$AC^2 - 2AC \times BD = CB^2 - 2CB \times BA + AB^2 = \overline{CB - BA}^2$, and $AC = BD + \sqrt{BD^2 + \overline{CB - BA}^2} =$
$150 + \sqrt{150^2 + 60^2} = 150 + 30\sqrt{29} = 311 \cdot 55494424 =$
the diftance from *Bifcay.*

And, by adding the fecond equation to the firft, we have
$AC^2 + 2AC \times BD = CB^2 + 2CB \times BA + AB^2 = \overline{CB + BA}^2$, and $CB + BA = \sqrt{AC^2 + 2BD \times AC} =$
$\sqrt{611 \cdot 5549 \& c \times 311 \cdot 5549 \& c.} = 436 \cdot 50082 =$ the whole dif-
tance run.

Alfo, by adding and fubtracting the difference and fum, we
have CB and $BA = \frac{436 \cdot 50082 \pm 60}{2} = 248 \cdot 25041$ and $188 \cdot 25041.$

The CONSTRUCTION is evident from the above procefs, *viz.*

Make $AC = (BD + \sqrt{BD^2 + \overline{CB - BA}^2} =)$ the fum of
BD and the hypothenufe of a right-angled triangle whofe two legs
are BD and $CB - BA$: then the fum of the legs $(CB + BA)$
being equal to $(\sqrt{AC^2 + 2BD \times AC})$ the mean proportional
between AC and $AC + 2BD$, the legs CB, BA themfelves will
be $=$ the half fum and difference of $CB - BA$ and the faid mean
proportional.

Your lofty firs, fo ftreight, fo fmooth, fo tall,
Each of them crowned with a golden ball:
One eighty foot, yet twenty foot out-done,
By his tall fellow, towring tow'rds the fun.
Between your trees is plac'd a fountain clear,
Nearer which ball, no mortal can declare,
A pleafure houfe is plac'd with fuch nice art,
That with the balls three equal lengths impart.
And if from thence you walk to th' fountain clear,
You to each ball at equal diftance are:
The diftance then betwixt each ball in meafure,
Alfo betwixt each ball and th' houfe of pleafure,
Likewife from th' houfe and bottom of each firr,
And from the houfe unto the fountain clear,
And from the fount to th' bottom of each tree,
The lines below, I hope, will let you fee.

From ball to ball — — —	121 65525
From each ball to the pleafure houfe	121 65525
From the lower tree bottom to the houfe	91 65151
From the taller tree bottom to the houfe	69 28203
From the houfe to the fountain —	52 67827
From the lower tree bottom to the fount	75
* From the higher tree bottom to the fount	45

The

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* The PRIZE QUESTION.

Let AD be the one tree, and BC the other. Draw CD the diftance of the two balls. On the middle of which and perpendicular to it draw GE, and E will be the fountain. For then DE will be $= EC$ by *Eucl.* I. 4.

Alfo the required path, at the end of which ftands the pleafure houfe, will be a right line EH perpendicular to AB, and $=$ one leg of a right-angled triangle whofe other leg is EA, and its hypothenufe $AH =$ the bafe of another right-angled triangle ADH whofe perpendicular is AD and hypothenufe $DH = DC.$——For, becaufe of the path's continual equal diftances from the balls, it will be the interfection of the horizontal plane and another plane perpendicular both to the line DC and the vertical plane $ABCD$, and this interfection is perpendicular to AB by *Eucl.* XI. 19.

The CALCULATION. Since $(ED^2 =) DA^2 + AE^2 = (EC^2 =) CB^2 + BE^2$; therefore, by equal fubtraction, $BC^2 - DA^2 = AE^2 - EB^2 = AB \times \overline{AE - EB}$; and

H 2

hence
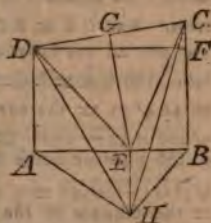
The same answered by *Mr.* Edward Walker.

In your fair garden garnished with flowers,
Circled with chrystal streams, and charming bowers,
Your pleasure house from the clear fount must stand
Fifty two feet, with some odd parts behind,
And from the bottom of the greatest tree,
Sixty nine, more by an half must be;
And for the rest, you here above may see.

The eclipses of this year 1712.

There will be four eclipses this year. The first is a small but visible eclipse of the moon, on january the 12th; it begins at 1 minute after 7 at night, the middle is at 52 minutes after 7, the end at 43 minutes after 8; the whole duration is 1 hour and 42 minutes, and will be about two digits and an half eclipsed on the north side.* The second eclipse is of the sun, on the 22d of june, at 10 at night, and therefore cannot be seen. The third is of the moon, the 8th of july, at 8 in the morning,

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hence $AE - EB = \dfrac{BC^2 - DA^2}{AB} = \dfrac{100^2 - 80^2}{120} = 30$:

Consequently AE and $EB = \dfrac{AB \pm 30}{2} = \dfrac{120 \pm 30}{2} = 75$

and 45, the distances of the fountain from the bottoms of the two trees. And $DE = EC = \sqrt{CB^2 + BE^2} = \sqrt{100^2 + 45^2} = 5\sqrt{481} = 109\cdot65856099$ the distance of each ball from the fountain. Also $DH = HC = CD = \sqrt{DF^2 + FC^2} = \sqrt{120^2 + 20^2} = 20\sqrt{37} = 121\cdot6552506$. Hence $BH = \sqrt{HC^2 - CB^2} = \sqrt{20^2 \times 37 - 100^2} = 20\sqrt{12} = 69\cdot2820323 = $ the distance of the pleasure house from the foot of the taller tree. $AH = \sqrt{HD^2 - DA^2} = \sqrt{20^2 \times 37 - 80^2} = 20\sqrt{21} = 91\cdot651513899 = $ the distance of the same from the lower tree. And $EH = \sqrt{HE^2 - BE^2} = \sqrt{20^2 \times 12 - 45^2} = 5\sqrt{111} = 52\cdot67826876 = $ the length of the walk, or the distance of the pleasure house from the fountain.

* This eclipse [January 12] was observed as follows:

I. At *Greenwich* by Mr. *Flamsteed*.

He says the middle of the eclipse was at 7 h. 40 m. 50 s. by the clock, or 7 h. 34 m. correct time. At which time the chord of the eclipsed part of the moon was 24. 30: but the greatest defect on *the northern side* was 8. 30. The moon's diameter 30. 48.

II. At

morning, and therefore invifible. The fourth is of the fun, on the 17th of december, at 1 in the morning, and therefore can't be feen.

New Arithmetical Queſtions.

I. *Queſtion* 23. *The widow's caſe, by Mr.* Lewis Even.

Ingenious ladies, whom their ſtars benign
Render'd their fates more happy far than mine :
Aſſiſt, I pray, ſo may you never ſee
Such difmal days as heav'n allotted me.
My ſecond-ſelf, the one half of my life,
Whom to ſurvive yields me the greateſt grief,
The fates unkind has ſnatch'd away in's prime,
I for this lofs ſhed tears more ſalt than brine ;
Depriv'd of all my joys and hopes at once,
The greateſt that all love could e'er advance ;

<div align="right">I be'ng</div>

II. At *Upminſter* by Mr. *W. Derham.*

h. m.

6	15	A duſkiſhneſs upon the N. E. ſide of the moon.
6	36	A thick penumbra on the moon.
6	37	The penumbra fo denſe that it may be taken for the beginning of the eclipſe.
6	39	The eclipſe undoubtedly is begun.
8	31	End of the eclipſe is very near.
8	32	End of the eclipſe.
8	32¼	Eclipſe is undoubtedly ended.
8	36	A penumbra is left.

III. At *Uratiſlavia (Breſlaw) by R. P. Chriſtopher Heinrich.*

h. m. s.

7	15	39	A duſkiſhneſs obſerved on the moon.
7	34	54	Beginning of the penumbra.
7	40	11	Beginning of thick darkneſs.
7	56	3	*Aldebaran* culminated.
8	38	7	*Orion's* weſtern foot culminated.
9	11	18	*Orion's* eaſtern foot culminated.
9	38	33	End of the thick ſhadow.
9	44	4	End of the penumbra.
10	9	17	*Sirius* culminated.

The ſolar time was meaſured by a pendulum clock, and corrected by the obſerved culminations of four fixed ſtars. And the quantities were determined by a micrometer in the teleſcope.

The ſhadow through the teleſcope ſeemed aſh-coloured, bluiſh, and approaching to blackneſs. It began to appear above *Ariſtarchus*, and then paſſed over the upper part of the moon.

I be'ng with child the time my dear lay ill,
He this provision made by his laft will.
T'th' child i'th' womb, if male, two parts in three
Of this his wealth he gave; one third to me.
But if by me the pow'rs above are pleas'd
The number of the fair fhould be increas'd,
Then I was to enjoy two parts in three;
One third fhould to my fair a fortune be.
My deareft dies: e're long was God's decree
Made known, how he was pleas'd to deal with me:
His blefsed pleafure was, that at one birth
I both a fon and daughter fhould bring forth.
This double birth, unthought of by my dear,
Makes th' execution of the will appear
Ambiguous unto me, and therefore I
Muft needs my felf to better heads apply.
Sev'n thoufand pounds my dear's eftate is priz'd,
In this odd cafe, I crave to be advis'd,
This to divide according to the will
Betwixt us three: I pray exert your fkill.
What ever priviledge the widows have
By force of law, moft willingly I wave:
To lawyer for advice I'll give no fee,
My hufband's will a law fhall be to me.

II. *Queftion* 24, *by Mr.* Amos Fifh.

I have holland, and muflin, and fcotch cloth good ftore,
I have cambrick, you never faw better before:
The number of ells of each fort I can't tell,
But the whole fum together, I remember right well,
Was juft thirty thoufand; nay, more I can fhow,
The firft and the laft I very well know,
Be'ng multiply'd together proved to be the fame fum,
To which the product of muflin and fcotch cloth did come,
And the fquares of the holland and cambriek when join'd
In one fum, will be one hundred fixty millions you'll find.
But the number of ells that each fort did contain,
I would willingly know, but I labour in vain,
And if you don't help, I'm afraid of my brain.
One thing I forgot, which is proper to tell,
The holland was moft by many fair ell.

III. *Queftion* 25, *by Mr.* Alexander Weeden.

If a fquare piece of timber be
Exactly twelve foot long;
Three inch the fide o'th' lefs fquare bafe,
The greater, twenty one:

Then

Then this I very fain would know,
　　How many feet in all;
And what's each folid foot's true length,
　　From greater bafe to th' fmall?

IV. *Queſtion* 26, *by Mr.* John Burnet.

Suppofe, fir, a bufhel be exactly round,
Whofe depth be'ng meafur'd eight inches is found;
If the breadth eighteen inches and an half you difcover,
This bufhel is legal all England over.
But a workman would make one of another frame,
Sev'n inch and an half muft be th' depth of the fame:
Now, fir, of what length muft th' diameter be,
That it may with the former in meafure agree.

V. *Queſtion* 27, *by Mr.* John Wilfon.

If to my months you fhould add half their fum,
And one eighth more, and then fhould fubtract one;
The refidue would fuch a number be,
As twenty one being fquar'd, affuredly.

VI. *Queſtion* 28, *by Mr.* Henry Beighton.

I hired a horfe, for to vifit my dear,
(A lovely fweet maid of complexion moft clear:)
At three pence a mile, for the hire we agreed;
So from London to Briftol I rid with full fpeed,
Being miles ninety four, and it lyeth full weft:
But when I came there my dear virgin I mift.
For fometime before fhe was gone to Weft Chefter,
With a man, as they told me, fhe huggl'd and kift, fir:
Nay, fo fond fhe was of him, fhe li't him to bed,
And for feveral hours there with him fhe ftaid.
This made me diftracted; fo away I fet forth
To Chefter, which lieth from Briftol full north.
I whipped and fpur'd, and I fcoured away,
And woman! falfe woman! was all I could fay.
But the number of miles I did ride, I can't tell,
My heart did with envy and paffion fo fwell.
　When I came to Weft Chefter, I found to my joy,
That it was her own father had took her away.
I ftreight made propofals to marry his daughter,
But he faid he'd take time for to think on the matter.
From Chefter to London we directed our aim,
And at fixty fix miles we to Coventry came:
Where I prefs'd things fo home, that we made up the match,
But to Briftol I muft firft fome writings go fetch.

(The

(The road's perpendicular to that we laſt came)
And they promis'd to ſtay till I came back again.
A young eager lover, you need not bid haſte,
When the nuptial joys he is ready to taſte.
Upon my return, we to London did go,
But the joy of our marriage tranſported me ſo,
That I never enquired the miles I did go.
Now the man for the hire of his horſe he has ſent,
And willing I am for to give him content:
But how much is due, neither him nor I know,
No more than the horſe that I rode on, I vow.
 Pray, ſir, be ſo kind as to tell me the ſum,
 And a bottle I'll give you when that way I come.

The Prize Queſtion, (of ten Diaries by lot) propoſed by Mr.
Peter Hingeſton, jun. (a ſcholar in Ipſwich grammar ſchool.)

Of the regular bodies platonick, you know,
The dodecaedron twelve faces does ſhow,
That are baſes of pentangled pyramids join'd,
By their tops at the centre. Now, ſir, I pray mind:
If, as large as each pyramid's bulk will admit,
All the baſes be dug into concaves, to wit,
Into hemiſpheres, cylinders, cubes too and cones,
Into pyramids likewiſe; triangular ones,
And quadrangular alſo; of each of theſe two;
(In each ſide one of them;) ſir, can you this do?
If the matter 'tis made of does weigh, being try'd,
For each ſolid foot ſixty pounds, and the ſide
Of each pentangle eight Inches be, and no more,
By geometry, what it weighs juſtly explore.

1713.

Solutions to the laſt year's Queſtions.

I. *Queſtion* 23, *anſwered by Mrs.* Anna Wright.

WHEN firſt the widow's mournful caſe I read,
 My ſympathizing heart with grief did bleed;
Her I'll aſſiſt, ſaid I, her doubts reſolve;
Then in my mind I did the caſe revolve:
Where ſoon the widow's ſhare by will I found,
To be no leſs than juſt two thouſand pound;
One thouſand pounds left to her daughter dear,
And juſt four thouſand to her ſon and heir.

I had

I had a great many excellent anſwers to this queſtion by Mr. *Moyle*, Mr. *John Wilſon*, Mr. *Newbold*, *Francius*, Mr. *Abel Ragg*, and others; but having ſo little room to ſpare, my fair reader, I hope, will pardon me if I inſert but one more ſolution of this queſtion, and one only of each of the enſuing.

* *The ſame Queſtion anſwered by Mr.* James Cole.

Diſpel thoſe clouds which hover o'er your head,
Since that your love, your deareſt love is dead;
To weep, and mourn, alaſs 'tis all in vain !
For you can never bring him back again !
If whilſt on earth, he walk'd in vertue's ways,
He now with joy ſings his redeemer's praiſe;
Which joy ſhall laſt beyond the reach or power
Of time, with's teeth of iron, to devour.
With winged ſpeed he's gone from cares below,
T' a place which mortals are too frail to know.
Therefore with comforts calm your troubl'd mind,
To think your huſband left thoſe cares behind.
As for the execution of his will,
And how the ſame you rightly may fulfil,
Look underneath, and there you'll plainly ſee,
The manner how th' eſtate muſt parted be.
(*Here followed the anſwer, being the ſame as above.*

II. *Queſtion* 24, *by Mr.* John Newbold.

Good Mr. *Fiſher*, I am your well wiſher,
　If draper or ſcotchman you be ;
And have ſent you the anſwer, as plain as I can, ſir,
　Tho' unſkill'd in the commodity.
In th' holland I'm right, and the cambrick white,
　But the other are dubious, whether
Are the greater o'th' two, ſo I leave it to you,
　Till time will permit you to meaſure.

　　　　　　　　　　　　　　　　　　　Twelve

---

* I. QUESTION 23. *ſolved.*

By the *will*, the mother's ſhare was to be the double of the daughter's, and the ſon's the double of the mother's ; wherefore they will be in proportion as the numbers 1, 2, and 4: and the ſum of theſe numbers being 7, it appears that the ſhares will be $\frac{1}{7}$, $\frac{2}{7}$, and $\frac{4}{7}$ of the whole eſtate : *viz.*

$\frac{1}{7}$ of 7000*l.* = 1000*l.* = the daughter's ſhare.

$\frac{2}{7}$ of 7000*l.* = 2000*l.* = the mother's ſhare.

$\frac{4}{7}$ of 7000*l.* = 4000*l.* = the ſon's ſhare.

Twelve thousand the first, four thousand the last,

The other two are * eight and * six; (* *i. e.* 8000 & 6000)
But the number to each are out of my reach,
There's no certainty when to affix. †

Holland 2200. muslin 8000, french cloth 5000, and cambrick 4000.

II. *Question* 23, *answered by* Francius.

The feet the number does contain, below you plain may find:
Likewise each foot's true length is shewn, according to your
(mind.

The first joint foot's length is 4°0136, the second is 4°2208,
the 3d is 4°4372, the 4th is 4°7272, the 5th is 5°0448, the 6th
is 5°42, the 7th is 5°8176, the 8th is 6°4408, the 9th is 7°1656,
the 10th is 8°0272, the 11th is 9°5208, the 12th is 11°7096,
the 13th is 15°1536, the 14th is 25°4824, and the 15 is 21°9104.

                  IV. *Ques-*

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* II. Q U E S T I O N 24. *solved.*

This question is maimed, for there are four unknown quanti-
ties, and only three conditions. And, to determine the rest, one
of them must be assumed.

Put z, v, s, r for the four quantities; then

$$z + v + s + r = 30000 = a,$$
$$zv = vs,$$
$$zz + rr = 16000000 = b.$$

To and from the third adding and subtracting the double of the
first, we have $zz \pm 2zz + rr = b \pm 2zy$; hence $z \pm v =$
$\sqrt{b \pm 2zy}$; then by substituting in the first, we get $y + s + \sqrt{b + 2zy}$
$= s$; from this is obtained $s = a - \sqrt{b + 2as - ss}$: by af-
suming $s = 8000$, this expression gives $y = 8000$. And then z

and $r = \dfrac{\sqrt{b + 2as} \pm \sqrt{b - 2sy}}{2} = 12000$ and 4000.

‡ III. Q U E S T I O N 25. *solved.*

By page 159 Mensuration, the solidity of the whole piece will
be $\dfrac{21 \times 21 + 21 \times 3 + 3 \times 3}{3} \times 12 \times 12 = 24624$ inches $=$
14¼ feet. And if the frustum be supposed to be compleated to
a pyramid; then, by similar triangles, as 21 — 3 is to 21, or
as 18 to 21, or as 6 to 7, so is 12 to 14 feet its altitude; and
hence $\dfrac{21 \times 21}{3} \times 14 \times 12 = 24696$ inches $= 14·291\frac{3}{4}$ feet $=$
the content of the whole pyramid. Whence, as similar solids are

the cubes of their like dimensions, we shall have $\sqrt[3]{14·2916}$:

$·916 : : 14$ feet or 168 inches : $168\sqrt[3]{\dfrac{13·2916}{14·2916}}$ inches, and
                                         168 —

* IV. *Question* 26, *answered by Mr.* Tho. Shepheard.

The diameter's length if the workman would know,
To please his nice fancy unto him pray shew,   *(inches*
The answer that I have here placed below, *(viz.)* 19·1067.

V. *Ques-*

$$168 - 168\sqrt[3]{\frac{13·2916}{14·2916}} = \frac{\sqrt[3]{14·2916} - \sqrt[3]{13·2916}}{\sqrt[3]{14·2916}} \times 168 =$$

$$\sqrt[3]{14·2916} - \sqrt[3]{13·2916} \times 69·228 =$$ the altitude of the lowest or
1st foot. And in like manner all the others will be found as below.

$: \sqrt[3]{14·2916} - \sqrt[3]{13·2916} : \times 69·228 = \quad 4·0134 =$ alt. of 1st foot

$: \sqrt[3]{13·2916} - \sqrt[3]{12·2916} : \times 69·228 = \quad 4·2203 = - - - $ 2d

$: \sqrt[3]{12·2916} - \sqrt[3]{11·2916} : \times 69·228 = \quad 4·4557 = - - - $ 3d

$: \sqrt[3]{11·2916} - \sqrt[3]{10·2916} : \times 69·228 = \quad 4·7273 = - - - $ 4th

$: \sqrt[3]{10·2916} - \sqrt[3]{9·2916} : \times 69·228 = \quad 5·0442 = - - - $ 5th

$: \sqrt[3]{9·2916} - \sqrt[3]{8·2916} : \times 69·228 = \quad 5·4205 = - - - $ 6th

$: \sqrt[3]{8·2916} - \sqrt[3]{7·2916} : \times 69·228 = \quad 5·8765 = - - - $ 7th

$: \sqrt[3]{7·2916} - \sqrt[3]{6·2916} : \times 69·228 = \quad 6·4406 = - - - $ 8th

$: \sqrt[3]{6·2916} - \sqrt[3]{5·2916} : \times 69·228 = \quad 7·1649 = - - - $ 9th

$: \sqrt[3]{5·2916} - \sqrt[3]{4·2916} : \times 69·228 = \quad 8·1354 = - - - $ 10th

$: \sqrt[3]{4·2916} - \sqrt[3]{3·2916} : \times 69·228 = \quad 9·5210 = - - - $ 11th

$: \sqrt[3]{3·2916} - \sqrt[3]{2·2916} : \times 69·228 = 11·7093 = - - - $ 12th

$: \sqrt[3]{2·2916} - \sqrt[3]{1·2916} : \times 69·228 = 15·8778 = - - - $ 13th

$: \sqrt[3]{1·2916} - \sqrt[3]{0·2916} : \times 69·228 = 29·4827 = - - - $ 14th

the sum 122·0896 being taken from
12 feet or 144·0000 inches, we have

21·9104 = alt. of the ¼ f.

* IV. QUESTION 26. *solved.*

Since equal cylinders have their altitudes reciprocally propor-
tional to the squares of their diameters, we shall have, As $\sqrt{7\frac{1}{2}}$:

$\sqrt{8} :: 18\frac{1}{2} : 18\frac{1}{2}\sqrt{\dfrac{8}{7\frac{1}{2}}} = 18\frac{1}{2}\sqrt{\dfrac{16}{15}} = \dfrac{74\sqrt{15}}{15} = $ 19·10671784

inches = the diameter required.

* V. *Queſtion* 27, *anſwered by Mrs.* Mary Nelſon.

To gueſs at your parts, by the length of your time,
You're fit for the ladies, and juſt in your prime.
If any thing more in your praiſe can appear,
Engage Mr. *Tipper* to incert it next year:
But ſince I'm obliged your age to diſcover,
You're juſt twenty two years, and eight months over.

† VI. *Queſtion* 28, *anſwered by the ſame.*

When this charming briſk laſs, you purſued ſo faſt,
From London to Briſtol, ſo on in ſuch haſte;
At three-pence a mile, as you agreed before,
I have ſet down the anſwer exact, and no more.

<div align="center">

Anſ. 5 *l.* 13 *s.* 2¼ *d.*   *Anſwer*

</div>

This queſtion being to find a number which being added to its one-half and one-eight ſhall make 442 (one more than the ſquare of 21); or, ſince the ſum of 1, ½, and ⅛ is $\frac{13}{8}$, to find a number which multiplied by $\frac{13}{8}$ ſhall produce 442; wherefore as 13 : 8 ::

$$442 : \frac{442 \times 8}{13} = 34 \times 8 = 272 \text{ months} = 22 \text{ years 8 months} =$$

his age.

† VI. QUESTION 28. *ſolved.*

CONSTRUCTION. Make AB, AC perpend. to each other, the former = 94 the diſtance between London and Briſtol, and the latter = 66 the diſtance between Cheſter and Coventry. Biſect AC in D, and with center D and radius Db deſcribe a circle meeting AC produced in E and F; then with the hypothenuſe AE and baſe $EG = AB$ form the right-angled triangle AEG; ſo ſhall E repreſent London, G Briſtol, A Cheſter, and C Coventry.
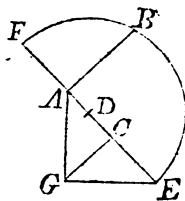
For, (having drawn CG) by ſimilar triangles, $GE^2 = EA \times EC$ = (by the conſtruction) $EA \times AF = AB^2$.

CALCULATION. The radius $ED = DB = \sqrt{BA^2 + AD^2}$ $= \sqrt{94^2 + 33^2} = \sqrt{9925} = 5\sqrt{397} = 99.62429$. Hence $CE = ED - DC = 66.62429 =$ the diſtance from Coventry to London; $GA = \sqrt{AE^2 - EG^2} = \sqrt{(AD + DE)^2 - EG^2}$ $= \sqrt{226.62429 \times 38.62429} = 93.55855$; and $GC = \frac{EG \times GA}{AE}$

or $= \sqrt{GE^2 - EC^2} = 66.31141$. Then $GA + AE + EG + 2GC = 452.80566$ miles = the whole diſtance travelled; which at 3 *d.* a mile will produce 5 *l.* 13 *s.* 2 *d.* 1.66792 *q.*

Anfwer to the Tinker's Queftion, by Mr. Richard Parker.

If the top of the kettle be lengthened on,
(With a figure that's juft like a fruftum cone,)
Six inches and thirty nine cents, and no more,
Will make it to hold twice as much as before.

* *Anfwer to the Prize Queftion.*

Tho' I received feven anfwers to this queſton, only three of them were right, (*viz.*) Mrs. *Barbara Sidway*, Mr. *Beighton*, and one more (who defired to conceal her name.) Mrs. *Sidway*'s anfwer was very fine, and in good verfe, but fo very long, I have not room to infert it: I fhall therefore only fet down the anfwer.

The dodecaedron weighs, after all the twelve cavities are cut out, 60·6527 pounds.

The

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* PRIZE QUESTION *folved.*

Let $ABEFGH$ be one of the twelve pyramids conftituting the dodecaedron, and C the center of its bafe: draw CD perpendicular to BE, and the reft of the lines as in the figure.

Putting $A = 8 = BE$ one fide of the pentagon or bafe, by page 410 Menfu-ration, we have $AC = A\sqrt{\dfrac{25 + 11\sqrt{5}}{40}}$ $= 1\cdot 113516\, A$; and $CD = \frac{1}{2}A \times$ tang. $54° = \cdot 68819095\, A =$ radius of the bafe of the cone. And, fince the greateſt inſcri-bed cylinder is known to be $\frac{4}{9}$ of the cone, we ſhall have $\frac{1}{9}CD^2 \times 3\cdot 14159$ &c. $\times \frac{1}{3}CA = 2\cdot 14916\, A^2 \times \frac{1}{3}CA =$ the the cone and cylinder together.——But

the greateſt triangle in the pentagon is BFG, and the greateſt qua-drangle is $BFGH$; the fum of thefe two is the $\triangle\, GHB +$ $2\triangle\, BFG$. Now the $\triangle\, GHB = GH \times HB \times \frac{1}{2}$s. $\angle H = \frac{1}{2}A^2 \times$ s. $108° = \cdot 47552825\, A^2$, and $2\triangle\, BFG = BI \times GF = A^2 \times \frac{1}{2}$ tang. $\angle BFI = A^2 \times \frac{1}{2}$ tang. $72° = 1\cdot 53884175\, A^2$; the fum of thefe two is $2\cdot 01437\, A^2 =$ the bafes of the triangular and quadrangular pyramids together; and confequently their contents together will be $2\cdot 01437\, A^2 \times \frac{1}{3}AC$.——Adding this to the fum of the cone and cylinder above found, we have $4\cdot 16353\, A^2 \times \frac{1}{3}AC$ $= 1\cdot 545386\, A^3 =$ the fum of thefe four folids.

Mathem.   I   Again,
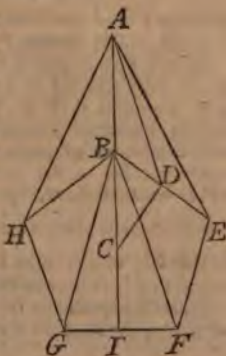
The Eclipses of this Year.

Of four eclipses which will happen this year, only one of them will be visible. The first is an eclipse of the moon, may 28, near half an hour after 6 in the afternoon, and therefore invisible. The second is an eclipse of the sun, on the 11th of june, half an hour before midnight, and therefore invisible to us, but will be visible to our antipodes. The third is a visible eclipse of the moon on november 21. The beginning will be at Coventry 8 min. after 2 in the morning; the middle at 18 min. after 3; and the end at 23 min. after 4 in the morning. The whole duration is 2 ho. 18 min. The digits eclipsed are 5 deg. very near. Lat. of the moon in the beginning

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Again, $DA = \sqrt{AC^2 + CD^2} = \dfrac{3 + \sqrt{5}}{4} A = 1\cdot309017\,A,$

and by similar triangles $AD : DC :: CA : \dfrac{AC \times CD}{DA} =$

$\dfrac{5 + 3\sqrt{5}}{20} A = \cdot5854102\,A =$ the radius of the inscribed hemisphere; and consequently its solidity is $\overline{\cdot5854102\,A}^3 \times \frac{2}{3} \times 3\cdot14159$ &c. $= \cdot4201837\,A^3.$

Also, a square may be inscribed in a pentagon by placing one of its sides parallel to a side of the pentagon; and, by calculation, it appears that, if z be the side of the square, $z \div 1\cdot0604974$ will be the side of the pentagon; hence, if this square be one face of the cube, and the pentagon the section of the pentagonal pyramid parallel to the base and distant from it the height of the cube, we shall have, by similar figures, $AC : BE :: AC - z : z \div 1\cdot0604974$; hence $z = \dfrac{1\cdot0604974\,AC}{1\cdot0604974\,A + AC} \times A = \cdot5431802\,A$ $=$ the side of the cube: And consequently the cube of this, or $\cdot1602626\,A^3 =$ the content of it.

Collecting now these three sums together, and multiplying by 2, we have $4\cdot2516646\,A^3$ for the contents of the twelve cavities.

But, by p. 408 Mensuration, $5A^3 \sqrt{\dfrac{47 + 21\sqrt{5}}{40}} = 7\cdot6631189\,A^3$ $=$ the content of the dodecaedron.

Consequently the difference of these two $= 3\cdot4114543\,A^3 = 1746\cdot6646016$ inches $= 1\cdot0108013$ feet $=$ solidity remaining; which at 60 lb. a foot, weighs 60\cdot648077 lb.

N. B. *False numbers (but no methods of solution) are given to this question in* The Diarian Repository.

A false solution is also given to question 25 in that book, dissimilar solids being used as similiar ones.

Other mistakes are remarked on the covers of this number.

beginning is 45 min. 42 fec. and at the end 39 min. 12 fec. north defcending, the lower or fouth limb of the moon being darkened. The fourth eclipfe is of the fun, on the 6th of december, 4 ho. 22 m. p. m. but invifible to us, the fun being below the weftern horizon.*

New Questions.

I. *Queftion* 29, *propofed by Mrs.* Sarah Brown.

I afk'd my love when fhe would wed?
  She cry'd fhe was too young;
And that fhe would ftill fome years ftay:
  I afked her, how long?
Until my years being multiply'd
  By't felf, and when you find
('Bating one-ninth, adding one-third)
  Nine hundred lacking nine:
I pray you, ladies, help me find
  What age fhe'll be when we are joyn'd.

II. *Quef-*

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* *The* 3d *Eclipfe or that for November* 21.
This eclipfe was obferved as follows:

I. At *Rome* by Mr. *F. Blanchin.*

Time
aftcrnoon
h. m. s.

12 53 34 A ftar in Taurus, by Bayer marked τ, nearly applied
          itfelf to the moon's limb; obfcrved by a telefcope of
          12 palms.
12 54 34 It was now hid by that part of the moon's limb, which is
          almoft in the middle between the fpots of Ariftarchus
          and Galileus.
14 0 14 Sirius came to the meridian, by which the times were
          verified.
15 0 • The penumbra in the limb of the moon, which before
          was pretty dilute, is now become fenfibly denfer.
15 4 20 The beginning of the incidence of the moon into the
          true fhadow, on that part of the limb which is next
          to the fpot Schickard.
17 27 45 The true fhadow comes out of the limb of the moon, in
          a place marked out by drawing a diameter between
          Ariftarchus and Plato.

II. At the town of *S. Jofeph,* which is 3 h. 52 m. 30 s. difference of
    meridian from R. Obf. Par. By *F. Bon. Suerez.*

10 33 31 Beginning
12 56 57 End

The greateft quantity obfcured was dig. 5 at about 11 h. 45 m.

I 2

II. *Queſtion* 30, *by* A. W.

At London one morning the ſun ſhining plain,
The ſhadow I found the juſt length of my cane,
As I held it upright; 'twas the tenth day of May:
Now tell me exactly the time of the day?

III. *Queſtion* 31, by *Mr.* Rob. Wilſon.

A caſtle wall there was, whoſe height was found
To be an hundred feet from top to th' ground:
Againſt the wall a ladder ſtood upright,
Of the ſame length the caſtle was in height.
A waggiſh fellow did the ladder ſlide
(The bottom of it) ten feet from the ſide.
Now I would know how far the top did fall,
By pulling out the ladder from the wall.

IV. *Queſtiou* 32, *by Mr.* Lover.

Three farmers did meet, as they rode on their way,
The firſt to the other two farmers did ſay,
If you give me two-thirds of each of your coin,
Then eighty ſix nobles will be equal to mine.
Nay, friend, ſays the ſecond, if I ſhould receive
Three-fifths of both yours, the ſame ſum I ſhall have:
But if from the two firſt, five-eighths the third take,
Then his the ſame eighty ſix nobles will make:
Inform me what each of them had at the firſt,
Likewiſe in exchanging what each man diſburſt.

V. *Queſtion* 33, *by Mr.* Peter Walter.

A noble lady of as noble parts,
Whoſe wit and beauty crown'd her queen of hearts:
Her noble works the learned world amaz'd,
As did the caſtles in the air ſhe rais'd.
　　In one of theſe a certain night ſhe laid,
　Nor did the caſtle's height make her afraid,
　Tho' in the air ſev'n meaſur'd miles 'twas rais'd.
　　On the next morn betimes ſhe did conſpire
By art to raiſe her ſeat a ſtory higher:
A fancy then had juſt receiv'd its birth,
When fell her ſtandiſh down from thence to earth;
At the ſame inſtant, ſhe a ſound did hear,
Which came from earth, and pierc'd her tender ear:
Well done, (ſaid ſhe) I'll of my ſelf demand,
(For why my fancy ne'er was at a ſtand)
How long my ſtandiſh was in falling thither;
How long the ſound was mounting till 't came hither.

Come artifts inform me how it is to be done;
There are many can tell me, but afk a round fum:
But knowing there generous perfons may be,
Who will do it for nothing, fuch will oblige me.

VI. *Queftion* 34, *by Mr.* Jofiah Clayton.

Sixty thoufand brave foldiers in battalia there were,
Plac'd in a vaft plain, and in form a long fquare:
Now on how many acres of ground did they ftand,
At two yards, three quarters, between man and man?
And how many in rank and in file will there be,
When their length to their breadth is as two is to three?

The Prize *Queftion, by Mrs.* Anna Wright.

Within the glorious firmament ferene,
Amongft the conftellations there is feen
The little bear, whofe tail's end now doth rowl
The neareft to the frozen northern pole.
But what ftar 'twas, is what I now require,
O'th' fecond magnitude that did appear
· To be to the north pole the next of all,
When firft God framed this terraqueous ball?
Since which are years (as beft accounts relate)
Fifty feven hundred and fixteen complete:
Its diftance from the pole, that time pray fhew,
And, when requir'd, I'll do as much for you.

1714.

Solutions to the laft year's queftions.

* I. *Queftion* 29, *anfwered by Mr.* Lingen *from* Ireland.

UNhappy man! behold how long you are condemn'd to ftay,
Before your love, your pains to eafe, has fix'd the joy-
ful day;
Till feven and twenty years fhe'as paft, relief ne'er hope to find,
If near that age fhe has arriv'd, then eafe your tortur'd mind.

By

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* I. QUESTION 29. *folved.*

Since $\frac{1}{9}$ taken from 1 leaves $\frac{8}{9}$, and this increafed by $\frac{1}{3}$ or $\frac{3}{9}$ be-
comes $\frac{11}{9}$; hence the queftion is to find a number whofe fquare
multiplied by $\frac{11}{9}$ may produce 891.
Confequently, 11 : 9 :: 891 : the fquare of the number,

$$\text{Or, } \sqrt{11} : \sqrt{9} :: \sqrt{891} : \sqrt{\frac{891 \times 9}{11}} = \sqrt{81 \times 9} =$$

27 = the number fought.

By *Mr.* Joſhua Lover *of* Chicheſter.

S ince 'tis a fair one this requeſt doth crave,
A loving huſband ſhe alſo ſhall have:
R ichly adorn'd with nature's comelineſs,
A nd let true vertue in each heart poſſeſs,
H appy are they thus providence doth bleſs.
B ut ſince 'tis age this fair one doth require,
R eady I am to grant her nice deſire :
O f what number, when ſquar'd nicely and true,
W hen one ninth, one third being put thereto.
N ow twenty ſev'n doth a-right anſwer ſhew.

Anſwered by Mr. Dan. Hatton *of Tewkeſbury.*

To a true lover, I diſcover,
   The charming maiden's years ;
Which ſhe may find, to eaſe her mind,
   Juſt twenty ſeven years.

* II. *Queſtion* 30, *anſwered by Mrs.* Adway,.

London, laſt may the tenth, in morning time,
   I trow, I calculate, or well projeſt,
The ſun's height forty five, the hour was nine,
   Minutes thirteen, ſeconds twice ten exaſt.

† III. *Queſtion* 31, *anſwered by Mr.* John Boſwell.

Six inches, half a quarter, the top did fall,
By pulling the ladder ten foot from the wall.

And by Mr. T. Buſey *of St. Nicholas in Kent.*

The ladder's deſcent muſt certainly be,
From th' top of the wall, as here under you ſee.
   ·50126 feet = 6 inches ·01512.

IV. *Queſ-*

Suppoſing the ſun's declination may 10th, 1712, to be 20° 16' 32" ; we ſhall have given the three ſides of a ſpherical triangle, to find an angle : viz. the complement of the declination = 69° 43' 28", the complement of the latitude = 38° 28', and the complement of the altitude = 45°, to find the hour angle, or angle between the two former ; and which by calculation comes out 41° 41' 4" = in time to 2 h. 46 m. 44 s. which being taken from 12 h. we have 9 h. 13 m. 16 s. for the time required.

† III. Q U E S T I O N 31. *ſolved.*

By right-angled triangles, $\sqrt{100^2 - 10^2} = 30\sqrt{11} =$ 99·4987437, which taken from 100, there remains ·5012563 feet = 6·0150756 inches = the number required.

* IV. *Queſtion* 32, *anſwered by Mr.* Edens.

Your knotty queſtions of the farmers, I
By algebraick art do here untye,
All which you aſk, exactly I diſcover,
Becauſe o'th' art, I find you are a lover.

The 1ſt had $30\frac{8}{17}$ nobles $= 10l.$ $11.$ $5\frac{1}{4}d.$ 187.
    2d $— 44\frac{6}{17}$ $—$ $= 14$ 14 $4\frac{3}{4}$ 888.
    3d $— 39\frac{10}{17}$ $—$ $= 13$ 3 5 329.

† V. *Queſtion* 33, *anſwered by Mr.* John Newbold.

Thoſe pyramids ſo often fam'd in ſtory,
For the world's wonder, and for Egypt's glory.
And Babylon ſo much by the antients prais'd,
Muſt loſe their fame, now your vaſt fabrick's rais'd.
The Alps, and Pico, ſeem their tops to droop,
And art bids nature's ſtately pride to ſtoop.

                                    The

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* IV. QUESTION 32. *ſolved.*

Putting $a = 86$ nobles, and z, y, x for the 1ſt, 2d, and 3d per-
ſon's nobles reſpectively; we ſhall have, by the queſtion,

$$x + \tfrac{2}{7}y + \tfrac{2}{7}x = a,\quad \text{Or } 3z + 2y + 2x = 3a,$$
$$y + \tfrac{1}{7}z + \tfrac{1}{7}x = a,\quad \text{Or } 3z + 5y + 3x = 5a,$$
$$x + \tfrac{5}{8}z + \tfrac{5}{8}y = a,\quad \text{Or } 5z + 5y + 8x = 8a.$$

Taking the 1ſt equation from the 2d, we have $3y + x = 2a$, or
$x = 2a — 3y$; this ſubſtituted in the 1ſt and 3d, we have

$$\left.\begin{array}{l}4y — 3z = a\\19y — 5z = 8a\end{array}\right\}; \text{ from 3 times the latter of theſe equations}$$

ſubtract 5 times the former, and there will be obtained $37y = 19a$;
hence $y = \dfrac{19a}{37} = 44\frac{6}{17}$ nobles $= 14l.$ $14s.$ $4d.$ $3\frac{23}{37}q.$ Then x
$= 2a — 3y = \dfrac{17a}{37} = 39\frac{10}{17}$ nobles $= 13l.$ $3s.$ $5\frac{3}{17}d.$ And z
$= \dfrac{4y — a}{3} = \dfrac{13a}{37} = 30\frac{8}{17}$ nobles $= 10l.$ $11s.$ $5d.$ $1\frac{7}{37}q.$

† V. QUESTION 33. *ſolved.*

Since ſound flies 1142 feet in a ſecond of time, we ſhall have
7 miles ÷ 1142 feet $= 36960$ feet ÷ $1142 = 32\frac{368}{571} = 32\cdot36427$
ſeconds $=$ the time of the aſcent of the ſound.

Again, Since the times of deſcent are as the roots of the ſpaces, and
$16\frac{1}{12}$ feet is the ſpace fallen in the 1ſt ſecond, wherefore $\sqrt{16\frac{1}{12}}$:
$\sqrt{36960}$ :: 1 ſecond : $\sqrt{\dfrac{36960}{16\frac{1}{12}}} = 47\cdot93778$ ſeconds $=$ the time
of the body's deſcent.

The vaft ficilian hill, whofe jaws expire
Thick clouds of duft, and vomit flames of fire,
Strikes not fuch wonders in beholders eyes,
Or ftupifies th' amazed faculties;
The architecture in their works does fhine,
As from the product of a power divine.
To name the height would be but labour loft,
Yet 'fear your expectation fhould be croft,
The numbers underneath, if manag'd right,
Will folve th' demand, and give the tow'ring height.
     The time it was falling was 48 feconds.

      Anfwered by Mrs. Mary Nelfon.

That lady fo fair, (with her ftandifh) i'th' air,
    Let fall from a place fo fublime,
Ere it came to the ground, or made any found,
     'Twas near forty eight feconds of time.
But before that her ear the found could well hear,
     So flowly it made its retreat,
Great Newton fo clear has made it appear
     'Twas forty eight feconds compleat.

   I received nine feveral anfwers to this queftion, with fome
fmall difference, in regard they calculated the acceleration
of defcent, and motion of founds, from different data. Of
which numbers were *Pylander*, Mr. *Parker*, *Richards*, *Wil-
fon*, and Mrs. *Sidway*; who fuppofing the univerfal meafure
to vibrate well at the caftle, after anfwering the queftion,
has propofed this following:

     Now in return, good fir, be pleas'd to try
To find the caftle's height, when rais'd fo high,
That in what time the ftandifh fell down hither,
So long the found was mounting till 't came thither.
When the weight touch'd the ground, tell what degree
It had acquired of velocity.   VI. *Quef-*

      Mrs. SIDWAY's *Queftion folved.*

Putting $a = 16\frac{1}{12}$, $b = 1142$, and $x = $ the height of the caftle
in feet. Then, as in the laft folution, $\frac{x}{b}$ will exprefs the time of
the found's afcent, and $\sqrt{\frac{x}{a}} = $ the time of the body's defcent;

hence $\frac{x}{b} = \sqrt{\frac{x}{a}}$, and $x = \frac{bb}{a} = 81087\frac{177}{193}$ feet $= 15$ miles

1887 $\frac{177}{193}$ feet $=$ the height of the caftle.

   And fince the velocity is as the root of the fpace defcended, and
2 *a* the velocity acquired by falling through *a*, we fhall have $\sqrt{a}$:
$\sqrt{x} :: 2a : 2\sqrt{ax} = 2\sqrt{bb} = 2b = $ double the velocity of found,
or 2284 feet per fecond.

* VI. *Queſt.* 34, *anſwered by* J. Lewes *of Landkey, Cornwall.*

If ſixty thouſand ſoldiers placed ſo be,
In rank and file, as two is to three;
Place 300 in rank, and 200 in file,
And the queſtion to anſwer you will not fail.
And on how many acres of ground they do ſtand, ⎫
At eight foot three inches between each man; ⎬
I anſwer, 'tis 92 acres of land.   (and 155 Perch.) ⎭

By Mr. Joſ. Boydall.

Your ſeſquialteral oblong ſquadron muſt ſtand
On ninety two acres, and three fourths of land:
And if they do your well-form'd order keep,
The rank's three hundred, and two hundred deep.

I received near 20 anſwers to this laſt queſtion: one half of them ſay, 'tis 93 acres and three quarters. The others, and the propoſer ſay, 92 acres and three quarters, and 35 perches. The former, I ſuppoſe, forgot to make the number of diſtances leſs by one than the perſons. And tho' I received abundance of curious anſwers to each queſtion, yet I am obliged to omit them, and ſhall conclude the anſwers with one ſent from Birmingham, that conciſely anſwers all the queſtions.

Till ſhe's full 27, your preud will not wed:
But ſooner by ten years I hope to be ſped. Q. 29
The time of the morning (if art we may truſt)
Was 9, 13 minutes, 40 ſeconds juſt.   30
If the bottom do ſlide 10 feet from the wall,
The ladder's top down 6 inches will fall.   31
In anſwer to th' next, you'd think me diſtracted,   32
Shou'd I put into rhime theſe † numbers ſo fracted.
If a body deſcends 16 foot (as 'tis reckon'd)   33
And found moves 1000 feet juſt, in one ſecond;
Then in 48 ſeconds the diſh came to ground,
And 37 more return'd back the found.
200 and 300 of the ſquare are the latera,   34
And 92 acres cover'd with a ſmall ‡ &c.

I write ſhort, but talk leſs, and out I go little;
If you like ſuch a wife, I'm yours, Dor. Dolittle.
† 30$\frac{8}{11}$. 44$\frac{6}{11}$. 39$\frac{10}{11}$.   ‡ 92 *acres* 3 *roods.*

In this method Mr *Will. Beriff* anſwered all the queſtions except the firſt.   *Anſwer*

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* VI. QUESTION 34. *ſolved.*

As the ſides muſt be in proportion to each other as 2 to 3, and their product 60000, it is evident that they muſt be 200 and 300. Then the ground upon which they ſtand will be $= 299 \times 2\frac{3}{4} \times 199$
$\times 2\frac{3}{4} = \frac{719908{,}21}{16}$ yards $= 92$ acres, 3 roods, 35$\frac{1}{2}$ perches.

* *Anſwer to the Prize Queſtion.*

To the prize queſtion propoſed laſt year, I received abundance of letters, in anſwer, (before Candlemas-day, on which the lots were drawn) out of which there were but four true anſwers, *viz.* by Mrs. *Barb. Sidway*, Mr. *Rich. Parker*, Mr. *John Edens*, and *H. B.* And that ſo many were miſtaken in their anſwers, there are two reaſons. Firſt, In Sir Jonas Moor's and ſome other catalogues, that ſtar (call'd by Kepler in his Rudolphine Tables Tertia ab Extrema in Cauda Draconis) is accounted of the 3d magnitude, and thoſe who had recourſe to theſe tables, took the middle ſtar in the great bear, or the guard-ſtar in the little bear's ſhoulder, to anſwer the queſtion. But thoſe who took Tyco's catalogue, or Seller's northern conſtellations, where that ſtar is of the 2d magnitude, truly anſwered the queſtion. A ſecond reaſon was, (tho' the difference is inconſiderable) ſome aſtronomers ſay the preſceſion of the equinox is 48, and others 50 ſeconds in a year.

At drawing the lots it fell to Mr. *John Edens*, who had ten diaries preſented to him, and anſwered thus:

> When th' great Jehovah fram'd the ſkies,
> He made the earth and ſtars likewiſe,
> And plac'd them all, as pleas'd him beſt,
> All rowling from the eaſt to th' weſt.
> Beſides that motion, he decreed,
> Contrarily they ſhould proceed;
> And make their revolution,
> Round to the place they firſt begun:
> Which in ſet times theſe ſubjects they
> Their mighty monarch's will obey.
>> If the account is right, as you relate,
>> Since God did firſt this earth create,
>> I'th' dragon's tail you may behold
>> The ſtar which next the north pole rol'd;
>> And if you view the ſcheme below,
>> Its diſtance from the ſame you'll know.

	°	′	″
The longitude of the firſt in ♈ 1712 - - - -	29	11	14
The ſtar in Draco from ♈ - - - - - - - - - ad.	124	33	30
Longitude of that ſtar, 1712 - - - - - - - - -	153	44	44
Moved in 5716 years - - - - - - - - - - - ſub.	80	52	53
Remains the long. at the creation - - - - - - -	72	51	51

Lat. according to Tyco, 66° 36′ north.   Then

As the cotan. 23° 30′ : is to the radius ::

So is the ſine of 72° 51′ : to the tang. 22° 33′, which ſubtract *from* the compl. of the ſtar's lat. leaves 90′ 12″.   Then

As

As the cofine   22ª 33″   To the cofine   50′ 12″
So is the cofine 23 30   To the cofine   6° 48

Six degrees forty eight minutes the diftance of that ftar from the pole at the creation.

Mrs. Sidway's *anfwer.*

That ftar o'th' fecond brightnefs that did roll
At the creation, next the northern pole,
Some call the dragon's tail; but others fay,
'Tis call'd of tail the antepenultima.
Its diftance then fix degrees and one half,
It has been much nearer, now further off.
When father Noah threefcore was, and odd,
More than five hundred years before the flood,
Scarce ten minutes from the pole it ftood.*

$\left.\rule{0pt}{4em}\right\}$
Of

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* P R I Z E Q U E S T I O N *anfwered.*

The annual preceffion of the ftars being 50·336 feconds of a degree, the preceffion from the creation to the year 1760 will be $=$
$5716 + 48 \times 50·336 = 5764 \times 50·336 = 290136$ feconds $= 80°$ 36′ 36″. To this preceffion add 3 figns or 90°, the longitude of the north pole of the equator, and we fhall have 5 s. 20° 35′ 36″ for the prefent longitude of the ftar required; and the ftar of the fecond magnitude, whofe longitude is neareft to that, and latitude 66 nearly, was the pole ftar required; which appears to be the third ftar in Draco, reckoned from the tip of the tail, which is the ftar marked, by Bayer, α.

Now to find the diftance of this ftar from the pole at the creation. By the catalogue of ftars at the end of the Nautical Almanac for the year 1773, the latitude of α Draconis is 66° 21′ 15½″, (its complement 23° 38′ 44½″), and its longitude in the year 1760 was 154° 2′ 46″; from this fubtract (80° 35′ 36″) the preceffion fince the creation, and we have 73° 27′ 10″ for the longitude of this ftar at the creation, whofe complement is 16° 32′ 50″: Alfo, fince the diminution of the inclination of the earth's axis is 47″ in 100 years, in 5764 years its change will be 45′ 9″, which being added to 23° 28′ 17″ the inclination in the year 1760, we fhall have 24° 13′ 26″ for the angle made by the axes of the ecliptic and equator at the creation. Hence in an oblique fpherical triangle, we have given two fides and the included angle, to find the third fide; *viz.* given one fide $= 24°$ 13′ 26″ the diftance of the pole of the equator from that of the ecliptic, the other fide $= 23°$ 38′ 44½″ the diftance of the ftar from the pole of the ecliptic, and the included $\angle = 16°$ 32′ 50″ the complement of the ftar's longitude: Then, by trigonometry, is found the 3d fide $= 6°$ 43′ 10″ the required diftance of the ftar from the pole of the equator at the creation.

Of the Eclipses.

An eclipse of the sun is caused by the interposition of the moon's dark body between the moon and our sight, for the moon being then under the sun, doth come in a direct line between the sun and our eyes, and so by the thickness and opakeness of her body doth obumbrate and hinder the sun from shining upon us; and this always happens at the conjunction of the sun and moon, or new moon, but not at every new moon; but only when the conjunction falleth in or near to either of the nodes, at which time she hath little or no latitude from the ecliptick.

An eclipse of the moon is caused by the direct interposition of the earth between the sun and her; then these three great bodies are all in one diametrical and straight line, the dark body of the earth being between the sun and moon, doth hinder the beams from shining on the moon, and so the moon having no light of her own, but what she receiveth from the sun by reflection, doth really become dark: and these eclipses always happen at full moon, but not at every full moon, but at such when she is in or near the ecliptick. And although

There will happen four eclipses this year 1714, yet not one of them will be visible in England.

The first eclipse is of the moon, on the 18th day of may, half an hour after 7 in the morning, but not visible to us, the moon being then set, but may be seen in Newfoundland in America.

The second is of the sun, the 1st day of june, invisible.

The third is of the sun, the 27th of october, at 5 in the evening, the sun being then set, therefore invisible to us.

The fourth eclipse is of the moon, the 10th day of november about noon, invisible.

These eclipses this year being so inconsiderable, I will give you an account of as great an eclipse as has happen'd in England these 50 years. It is of the sun, the 22d day of april, 1715, beginning 6 minutes after 8 in the morning, and lasts above two hours: the sun will be so totally obscured for the space of 2 minutes and a half, that the stars will appear as though it was night. A full account of this eclipse you shall have in my next.

New Arithmetical Questions.

I. *Question* 35, *propos'd by* Mr. John Wilson.

Assist you ladies, that in art are skill'd,
And have the bitter sweets of love once feel'd;
You I invoke, and on your aid rely,
To help me in my great'st extremity.
Oh! how the scene is chang'd, as in a trice,
I who could others counsel, want advice.
My sweet Eliza was so charming fair,
That Dian's nymphs might none with her compare:
Nor was her face so charming as her mind,
Her chaste love free, and to her swain was kind,
But above all, her intellectual part
Was virtuous, witty; constant was her heart.
This render'd me, when in Eliza's arms
I lay, incircl'd 'midst a thousand charms,
The happy'st mortal breathing on the earth:
But now my torment's far more worse than death,
Till you, fair ladies, your assistance lend,
And give an answer to the lines I send.
Eliza's father, cruel both to me
And to my dear Eliza, furiously
Snatch'd my dearest from m'encircling arms,
And utterly denies our future charms,
Till I shall count the portion of my dear,
And what he's worth in all, to him declare.
' Three sevenths of 's estate my dear's to have:
' The other four to his own use he'll save.
' Now what's estate is worth I fain would know;
' But he no more than this will to me show:
' The pounds being cub'd, the product of that sum
' Will to a number of nine figures come:
' Which by the squares of eight and three divide,
' And in the quotient still there will abide
' Thousands three hundred fifty two, and more,
' Nine hundred forty seven: On which I pore
Both day and night; but I no good can do:
Therefore my whole dependence lies on you.

II. *Question* 36, *by Mrs.* Barbara Sidway.

A gardiner he had an upright cone,
Out of which should be cut him a rolling stone,
The biggest that e'er it could make.
The mason he said, that there was a rule
For such sort of work, but he had a thick skull.
Now help him for pity's sake.
    Mathem.   K   III. *Ques-*

III. *Queſt.* 37, *by Mr.* John Hodge, *of Truro, in Cornwall.*

Two eſquires of late, of noble eſtate,
 Once happ'ned to fall at diſcord;
Their wrath grew ſo high, nothing could pacifie,
 But the law or the point of the ſword.
Their counſellors were a jolly briſk pair,
 And having good clients in hand,
Reſolved to uſe them as friends (not abuſe them)
 As by this you may underſtand.
In tavern being met, they concluded it fit
  ᷍ This matter in law to delay,
So long as they nine could change places to dine,
 And make but a change ev'ry day.
 How long muſt they ſit, tell I pray?

IV. *Queſt.* 38, *by Mr.* Crabb *of Whitlackington in Somerſet.*

A gentleman with his artif'cer did
Agree for building a round pyramid;
And for each foot ſolid the ſame did contain,
Seven pence was the price; no more, loſs or gain:
And now, I muſt tell ye, it was his good pleaſure
To have it be made, juſt after this meaſure;
That when it was rais'd, in inches ſix ſcore,
Twelve hundred and fifty foot ſolid be more
Built thereon: and let the height in this caſe,
From the top o'th' ſame, to the center o'th' baſe
Be in proportion to the circuit there,
As five is to four: and now obſerve here,
'Twas alſo agreed, that for the ſame pay, }
To have a room in't, made ſquare ev'ry way, }
As large as the cone would admit of, I ſay. }
But I am in doubt, he can't do't alone:
Pray help him therefore in building this cone.
And th' girt at the baſe, with th' height to him give, }
With the ſide of th' room, and what he muſt have }
For building this cone, is all I do crave. }

V. *Queſt.* 39, *by Mr.* Richards, *of St. Thomas's, nigh Exon.*

The firſt king of Aſſyria, Ninus by name,
Took to wife Semiramis, that valorous dame,
Who repair'd old Babylon, when 'twas decay'd;
And by her great courage made her foes afraid.
But one thing to her fame I think proper to quote,
Which is of all others the moſt proper to note:
'Tis that obeliſk of marble ſhe caus'd to be ſet
From the armenian rocks, and in Babylon ſet.

       It

It was pyramid like; the bafe twenty foot fquare,
'Twas of one folid ftone, and (as authors declare,
If meafur'd) one hundred befides fifty foot high:
This carriage was prodigious, you'll quickly reply.
Now (pardon the wildnefs of my fancy) fuppofe
Being funk in Euphrates, it were thence to be rofe,
What weight were fufficient this ftone to raife up,
Till the point of the fame fhould appear at the top,
Or furface o' th' water? befides how much weight more
Muft be added to bring it as it was before
It was fuch? I mean, the whole ftone above water;
For when we have done this, we have finifh'd the matter:
For I hope they'll take care and not fink it again,
If Euphrates falt water its weight will fuftain.

VI. *Queftion* 40, *by Mr.* John Newbold.

In walking the ftreet, I met with a brifk blade,
An honeft old lad, and a cooper by trade:
He was merry in mind, but his whiftle was dry;
You'd have laugh'd your guts out in hearing him cry
Any buckets or tubs, any barrels to mend;
Here's hoops of all fizes: pray make ufe of a friend.
I obferv'd him a man of abundance of tattle,
And that moft of his knowledge confifted in prattle;
Then refolv'd with myfelf that I'd give him a rub;
So I afk'd him to make me a conical tub;
Its bafe thirty inches, and a hoop there fo wide
Should, if placed upright, the whole tub circumfcribe;
And with the four ends of the diameters right,
And hold in ale gallons, nineteen ninety eight.   (19·98)
To work he ftreight went; but foon found that his fkill
Was too fhallow the problem propos'd to fulfill:
So defires in this letter the favour from you,
To fend the requeft underneath very true:
The depth of the tub, and diameter leaft,
And hopes that the ladies will grant the requeft:
And as a reward (now his brains are grown dunch)
He'll treat them next year with a tub full of punch.

The PRIZE QUESTION, *of* 10 *Diaries, to be determined by
Lot among thofe who anfwer it before Candlemas.*

[As this Queftion is propofed in very bad verfe, I fhall
here turn it into plain profe.]

In gauging a fpheroidical ale cafk, I found the diameter of
one head to meafure 18·1 inches, that of the other 16, the
bung diameter 20, and the diftance between the two heads 36
inches; alfo, by the cafk lying a little obliquely, I obferved
that

that the liquor juſt roſe to, or touched, the upper extremi-
ties of the two heads.. Having noted theſe dimenſions, I was
informed that there were in the caſk a ball of iron weighing
60 *lb*. another ball of lead weighing 90 *lb*. and a cube of box,
a foot ſquare. Pray what quantity of liquor was in the caſk.

1715.

Solutions to the laſt year's Queſtions.

* I. *Queſtion* 35, *anſwered by Mr*. Peter Walkær, *and Mr*.
Ja. Cole, *of Portſmouth*.

> G OOD ſir rejoyce, now you your point ſhall gain,
> And in your arms your charming fair detain;
> Then to her father with aſſurance go,
> - Tell him you do his daughter's portion know,
> For 'tis the number which you find below. }

The father's eſtate, 588 *l*. The daughter's portion, 252 *l*.

The ſame anſwered by Mr. William Vorley, *writing maſter
at Holbech, Lincolnſhire*.

> You may marry Eliza as ſoon as you will,
> For I've found out her father's eſtate by my ſkill
> In arithmetick, if that I be right,
> To be pounds five hundred eighty and eight;
> Yet to be more kind, unto you I'll ſhew,
> That pounds two hundred fifty and two,
> Is her juſt portion. I joy her to you. }

This queſtion was anſwered by Mr. *Moyle*, Mr. *Hatton*,
Mr. *Shepheard*, Mr. *Crabb*, Mr. *Lingen*, Mr. *Cooch*, Mr.
Beriff, Mrs. *Jone Jolly*, Mr. *Hall*, Mr. *Elphick*, *Gynæphi-
lus*, Mr. *Hayward*, Mr. *Carter*, Mr. *Ragg*, Mr. *Widdows*,
Mr. *Woodham*, Mr. *William Bainham*, Mr. *Edens*, Mrs.
Nelſon, Mr. *Williams*, and others.

II. *Queſ-*

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* I. Q U E S T I O N 35. *ſolved*.

Since the cube of the number of pounds in the whole eſtate is
equal to 352947 × 64 × 9 = 203297472, the number itſelf muſt
be equal to the cube root of this number, which is 588 *l*. = the
whole eſtate. Conſequently ⅖ of 588 = 252 *l*. is the lady's portion

* II. *Queſtion* 36, *anſwered by Mr.* Newbold.

Honeſt maſon, thro' Mrs. Sidway's perſwaſion,
 I'll ſhew you the way for to cut
The greateſt cylinder out, of all cones without doubt,
 And this is the way you muſt do't:
Through the middle of its height, cut the cone right
 To its axis, and then you will find,
A cylinder in this caſe, muſt have ſuch a baſe,
 For the greateſt to be of its kind.

Mr. *Beriff*, Mr. *Hall*, Mr. *Wylde*, and Mr. *Clayton*, ſay it muſt be cut thro' $\frac{1}{3}$ of its height, agreeing to the propoſer. Mr. *Williams*, Mr. *Andrews*, Mr. *Crabb*, and Mr. *Cole* anſwered this queſtion.

† III. *Queſtion* 37, *anſwered by Mr.* Tho. Dodd.

 May ſuch amuſements always end raſh ſtrife,
Deſtructive of the peaceful ſweets of life:
Had they but ſat each day in diff'rent range,
And liv'd to ſee how often they could change,
They'd ſeen more days than all *Methuſalah*'s
Juſt twenty four, with ſix and nine ſcore days.

And by Mr. Lingen, *and Mr.* Nath. Kew, *of Bath.*

How few can we find, ſo good of that kind,
 So generous, ſo wonderful civil';
I have felt the curſt claws of ſome traders in laws:
 Deliver us Lord from that evil.

They muſt have continued 993 years, and 186 days.

•

      IV. *Queſ*-

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* II. QUESTION 36. *ſolved.*

From ſeveral ſolutions that have been given of this queſtion, it is very certain that the cone muſt be cut at *one-third* of its altitude.

† III. QUESTION 37. *ſolved.*

The time required will be $= 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 \times 9 =$ 362880 days; which, at $365\frac{1}{4}$ days to the year, come to $993\frac{1.4.4}{1.4.6}$ years.

* IV. *Queſtion* 38, *anſwered by Mr.* John Newbold, *Mr.* Lewis Evan, *Mr.* Abel Ragg, *Mr.* John Andrew, *Mr.* Nich. Stevens, *and Mrs.* Nelſon.

What human pleaſures more delight the mind,
Or ſolid notions ſatisfaction find,
Than centred are in mathematick ſkill;
The ſweet endowment of that ſplendid quill.
——— The queſtion 38 is ſo ſublime,
It makes the nine harmonious numbers chime
Into a theorem of a high degree,
Surſolid much adfected it will be;
Which I determine by converging ſeries,
And underneath have ſolved all its queries.

	feet	inch.
The circumference of the pyramid at the baſe	41	6
The whole height of the cone - - - - - - -	51	10
The ſide of the room - - - - - - - - - - - -	7	11

The content in ſolid feet when the room is deducted, 1878·1093. The charge of the building, 54 *l.* 15 *s.* 6 *d.*

V. *Queſ-*

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* IV. QUESTION 38. *ſolved.*

Put $a = $ ·785398 &c. and $5x$ and $4x$ for the altitude and circumference of the upper part whoſe content is 1250. Then its ſolidity is $\frac{5x^3}{3a} = 1250$; hence $x = \sqrt[3]{750a} = 8$·382697. Conſequently the altitude of the whole cone $= 5x + 10 = 51$·913485 feet $= 51$ feet 10·96181 inches, and the circumference of its baſe $= 4x + 8 = 41$·53078 feet $= 41$ feet 6·369456 inches: Alſo, by ſimilar ſolids, $5x^3 : \overline{5x+10}^3 :: \left(\frac{5x^3}{3a} =\right) 1250 : \overline{\frac{x+2}{x}}^3$ $\times 1250 = 2375$·14 $=$ ſolidity of the whole cone.

Now, if $A = 5x + 10 = 51$·913485 the altitude of the whole cone, and $z = $ the ſide of the inſcribed cubical room; by ſimilar figures we ſhall have $A : \frac{A}{10a} :: A - z : \frac{1}{2}z\sqrt{2}$; hence $z = \frac{A}{1 + 5a\sqrt{2}} = 7$·921364 feet $= 7$ feet 11·056368 inches $=$ the ſide of the room; the cube of which gives 497·05 for the vacuity.

Taking this from the whole ſolidity (2375·14) we obtain 1878·09 for the ſolid part; which, at 7 *d.* a foot, produces 54 *l.* 15 *s.* 6 *d.* 2·529.

* V. *Queſtion* 39, *anſwered by Mr.* Newbold.

When noble thoughts inveſt a noble foul,
And martial ardours all the mind controul;
When female fpirits dare encounter thofe
Sad dangers we to fancy fcarce fuppofe;
Darting their courage through their fplendid eyes,
And mafter danger with the leaft furprize:
Oh ! Semiramis, what ſtrange acts I find
Recorded of thy elevated mind,
Efpecially the ſtately pile thou'ſt fet
In *Babylon*, has made thy works complete,
And fet the poets wits at ſtrife to feign
Sufficient words t' immortalize thy name.
Some fain would know how much 'twill weigh
when in the air, and in the fea.
And for to pleafe the minds of thofe
Their whole requeſts I here difclofe.

	Tun.	*cwt.*	*qr.*	*lb.*
To raife it to the furface — — —	939	3	2	10
To be added to raife it out — —	573	12	3	25
The weight in the air — — —	1512	16	2	7

This calculus is according to Mr. *Ward's* tableš of fpeci-
fick gravities, and differs confiderable from thofe taken from
Philofophical Tranfactions.

To this queſtion I received true anfwers from Mr. *Peter
Ward*, Mr. *Tho. Fearne*, Mr. *Crabb*, Mr. *Beriff*, Mr. *Hall*,
Mr. *Edward Elphick*, Mr. *Abel Ragg*, Mrs. *Mary Nelfon*,
and Mrs. *Carrington*.

To the 40th queſtion I received but one anfwer, from Mr.
Edens; although I conceive the queſtion very well explains
the meaning, yet I find moſt perfons were at a lofs in an-
fwering it. 'Tis no more but to find a fruſtrum of a cone
that

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* V. QUESTION 39. *folved.*

The folidity of the pyramid will be $20^2 \times \frac{150}{3} = 100000$ feet $=$
3456000 cubic inches. Now by *Ward's* table of fpecific gravities,
a cubic inch of marble weighs 1·568859 ounces avoirdupois, and
an inch of falt water ·594894 ounces; and their difference is ·973965.
Whence, the weight required to raife the point of it to the furface
of the water will be ·973965 × 34560000 = 33660230·40z. = 939
tons 3 *cwt.* 2 *qr.* 12 *lb.* 6·40z.

And it is evident that the whole weight of the marble will be
neceſſary to raife the whole of it above the water.

that will hold 19 gallons, and 98 hundred parts, whofe greateft hoop's diameter is 30 inches, when placed perpendicular to the veflel, fhall touch the two ends of each diameter, the leaft diameter muft be 18·236 inches, and depth 11·9104 inches.*

Mr. *Richard Ford* anfwer'd all the fix queftions in one copy of verfes, which came too late to be inferted.

Anfwer to the Prize Queftion.

To the prize queftion propofed laft year, I received a confiderable number of anfwers; but the difference among authors concerning the fpecifick gravity of metals, and the various theorems by which they found the content of the cafk, and its vacuity, caufed fome (tho' inconfiderable) difference. It would be endlefs, as well as needlefs, (in my fmall room) to give you an account of the whole operation, which could not well be explain'd without a figure of the fpheroid, and the algebraick theorems deduced therefrom, and would thereby be troublefome, as well as uncommon in a work of this nature; I fhall therefore omit that, and only incert fo much as anfwers the demands in the queftion.

Mr.

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* VI. Q U E S T I O N 40. *folved.*

Put $2a = 30 =$ the bottom diameter, $2x =$ the top diameter, and $A =$ the content in ale gallons. Then, by the nature of the circle, $\sqrt{aa - xx} =$ the perpendicular depth; and, by page 159 Menfuration, we have $4 \times \overline{aa + ax + xx} \times \sqrt{aa - xx} \times \frac{\cdot 78539 \&c.}{3} = 282A$, where $282 =$ the inches in a gallon; or

$$\overline{aa + ax + xx} \times \sqrt{aa - xx} = \frac{846 A}{3\cdot 14159 \&c.}.$$ Now when $A = 19\cdot98$ as in the queftion, there is no number, taken as the value of x, will produce fo great a content, the number $19\cdot98$ being above the maximum. But to find the greateft content the cafe will admit of, put the fluxion of $\overline{aa + ax + xx}|^2 \times \overline{aa - xx} =$ to nothing, and we fhall have $0 = \overline{aa - xx} \times \overline{a + 2x} - x \times \overline{aa + ax + xx} = a^3 + a^2 x - 2ax^2 - 3x^3$; or in numbers $x^3 + 10x^2 - 75x - 1125 = 0$; or, putting $z = \frac{1}{3}x$, $z^3 + 2z^2 - 3z + 9 = 0$; the root z of this equation is $= 1\cdot9394$; confequently $2x = 10z = 19\cdot394 =$ the value of the lefs diameter when the content is a maximum; and then the depth $\sqrt{aa - xx}$ is $\mp 11\cdot444$, and the greateft content $=$

$$\overline{30^2 + 30 \times 19\cdot349 + 19\cdot349^2} \times \frac{11\cdot444}{3} \times \frac{\cdot 78539 \&c.}{282} = 19\cdot739$$

ale gallons.

Mr. *John Newbold*, and Mr. *John Edens*, have geometrically demonſtrated, and algebraically wrought each demand. An abſtract of which follows after Mr. *Edens'* anſwer in verſe.

> To the ingenious ſons of art I write,
> Who in the mathematicks take delight. ·
> To cenſure others 'tis not my intent,
> But to the gauger my reſpects preſent.
> Hard was his fate that he this barrel found,
> Such are not common in a gauger's round;
> For if they were, others as well as he,
> Would often at their *ne plus ultra* be:
> At his requeſt I here ſend my aſſiſtance,
> And from each head to th' bung the diſtance,
> And what the barrel holds I make appear,
> And what remains, tho' vulcan's craft was there.
> Now ſince this taſk did poſe the gauger ſo,
> Pray ſhew to him what I have done below.

	inches
The ſpheroid's greateſt diſtance from bung to head	12·053
The leſſer diſtance — — — —	8·547
The content of the caſk in ale gallons . — —	20·763
The iron ball equal to cubick inches — —	217·048
The leaden ball — — — — —	219·717
The caſk's vacuity — — — —	117·814
The box emerged — — — —	1723·000
The ſum, cubick inches · — — —	2277·579
which are equal to ale gallons	8·076

which deducted from the whole content·leaves 12·687 ale gallons, the true quantity of liquor remaining in the caſk.

At drawing the lots, Mrs. *Anne Morgan* won the prize.

Mrs. Mary Nelſon, *of Newmarket, anſwers thus.*

> Alas poor man ! you're in a ſad condition;
> Who can refuſe to anſwer your petition ?
> If th' ladies grant you not relief with ſpeed,
> You may at laſt be ſo reduc'd indeed
> To ride like Hudibras, on ſuch a ſteed.
> But ſince you are in ſuch a pitious caſe,
> For once, I'll ſave your credit and your place:
> Here underneath I've anſwer'd all your queries,
> Which gives me one fair chance to win the diaries.
> *(Here follow'd the anſwer as above.)*

Mr.

·Mr. William Crabb's *anfwer to the Prize Queſtion.*[*]

Why muſt ladies turn gaugers, unlefs't be for wagers,
    And fave a young man from undoing:
Muſt they be frightned all, with bullets and ball,
    And a cube too; but this enſuing,
May make it more eaſie, if it may pleaſe ye,
    To take care of miſtakes in the matter:
For the cube I do fear, had no part in the air,
    Nor room to fwim, kept it under water.
    (Refponf. ut fupra.)

The

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[*] PRIZE QUESTION *folved.*
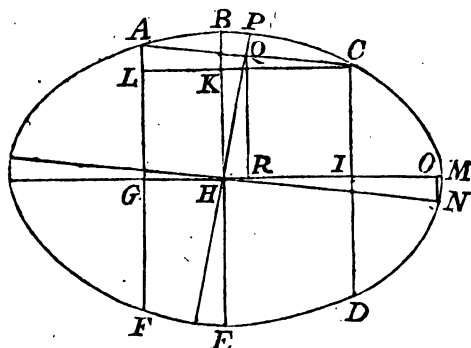
Let *ACDF* be the caſk, *BE* the conjugate axe, and *HM* the
femitranfverfe; *CL* ‖ to *HM*, *HN*, ‖ to *AC*, *HQP* the femi-
conjugate of *HN*, and *NO* and *QR* ‖ to *BE*.

By the nature of the ellipfe, we have

$$\sqrt{HB^2 - GA^2} : \sqrt{HB^2 - IC^2} :: LK : KC; \text{ and, by compof. &c.}$$

$$\sqrt{HB^2 - GA^2} + \sqrt{HB^2 - IC^2} : LC\ (= LK + KC)$$

$$\begin{cases}
\sqrt{HB^2 - GA^2} : LK = \dfrac{LC \times \sqrt{HB^2 - GA^2}}{\sqrt{HB^2 - GA^2} + \sqrt{HB^2 - IC^2}} \\[2mm]
\qquad = \dfrac{20\cdot6 \times \sqrt{10^2 - 9\cdot05^2}}{\sqrt{10^2 - 9\cdot05^2} + \sqrt{10^2 - 8^2}} = 8\cdot5463. \\[4mm]
\sqrt{HB^2 - IC^2} : KC = \dfrac{LC \times \sqrt{HB - IC^2}}{\sqrt{HB^2 - GA^2} + \sqrt{HB^2 - IC^2}} \\[2mm]
\qquad = \dfrac{20\cdot6 \times \sqrt{10^2 - 8^2}}{\sqrt{10^2 - 9\cdot05^2} + \sqrt{10^2 - 8^2}} = 12\cdot0537.
\end{cases}$$

And,

The Prize Question answered by R. Sandford.

Well, look you here good question spoil'd,
  Cot knofe was nere fee like, fir;
Was put good ale for verjuice, child,
  Splut was in a paffion ftraight, fir.

(*The anfwer as above.*)

Befides

And, $\sqrt{EK \times KB} : KC :: BH : HM = \dfrac{BH \times KC}{\sqrt{EK \times KB}} = \dfrac{120\cdot537}{6} = 20\cdot0895.$

Alfo, by right-angled $\triangle$s, $AC = \sqrt{CL^2 + LA^2} = \sqrt{20\cdot6^2 + 1\cdot05^2} = 20\cdot62674$; and fine of $\angle ACL = \dfrac{LA}{AC} = \cdot0509048 = $ fine $\angle NHM$, which put $= s$, and its cofine $= c$.

Then, by the nature of the ellipfe,
  $MH^2 : HB^2 :: MH^2 - HO^2 : ON^2$;
  but $HO = HN \times c$, and $ON = NH \times s$, wherefore
  $MH^2 : HB^2 :: MH^2 - HN^2 \times c^2 : HN^2 \times s^2$, or by fubtraction
  $MH^2 - HB^2 : HB^2 :: MH^2 - HN^2 \times \overline{s^2 + c^2} :$
    $HN^2 \times s^2$, or fince $s^2 + c^2 = 1$
  $MH^2 - HB^2 : HB^2 :: MH^2 - HN^2 : HN^2 \times s^2$, or
  $\overline{MH^2 - HB^2} \times s^2 : HB^2 :: MH^2 - HN^2 : HN^2$,
    and by addition
  $\overline{MH^2 - HB^2} \times s^2 + HB^2 : HB^2 :: MH^2 : HN^2$,
    and hence

$NH = \dfrac{MH \times HB}{\sqrt{HB^2 + s^2 \times \overline{MH^2 - HB^2}}} =$
$\dfrac{MH \times HB}{\sqrt{HB^2 \times c^2 + MH^2 \times s^2}} = 20\cdot01094.$

Alfo, its femi-conjugate $PH = \sqrt{MH^2 + HB^2 - HN^2} = 10\cdot15629.$

But $HR = \dfrac{IH - GH}{2} = 1\cdot7537$; and $RQ = \dfrac{GA + IC}{2} = 6\cdot525$; and, by right-angled triangles, $HQ = \sqrt{QK^2 + RH^2} = 8\cdot703511$; confequently $QP = PH - HQ = 1\cdot45278.$

Then,

Befides the above-fpecify'd, thefe following anfwer'd it: Mrs. *B. Sidway,* Mr. *N. Stephens,* Mrs. *Staples,* Mr. *John Whittingham,* Mr. *Bofwell,* Mr. *Ford,* Mr. *Berrifte,* Mr. *T. Fenton, Conft. Love,* Mrs. *Hill,* and Mr. *Moufe.*

> You tell us a tale of a tub of good ale,
>   That can buoy up the box in the liquor; ·
> But 'twas fill'd with rum, or elfe fure with mum,
>   Or fomething ftill ftronger and thicker.

The Eclipfes of this Year.

Twice this year, 1715, fhall the earth in part be deprived of the fun's illuminating radiancy, by the interpofition of the opacous body of the moon; and twice alfo fhall the moon be deprived in part of her fun borrow'd luftre, by reafon of the earth interpofing between the fun and her.

The firft is a great eclipfe of the fun, on friday the 22d of april, at 9 in the morning; vifible to us in England.

The

Then, by cor. 2 page 275 Menfuration, the content of the fegment APC will be $3\cdot14159$ &c. $\times MH \times HB^2 \times \mathcal{Q}P^2 \times \dfrac{HP - \frac{1}{3}P\mathcal{Q}}{PH^3} = 122\cdot9787$ inches $=$ the vacuity.

But the content of the box cube is $12^3 = 1728$; all of which will be immerfed, becaufe it is heavier than ale. Alfo, ufing Ward's table of fpecific gravities, the folidity of the iron ball will be $\dfrac{60 \times 16}{4\cdot422979}$

$= 217\cdot0483$; and that of the leaden one $\dfrac{90 \times 16}{6\cdot553885} = 219\cdot717$.

The fum of thefe three added to the above fegment, gives $2287\cdot744$ for the fum of the deductions.

Now the content of the whole cafk is $\overline{2EB^2 + FA^2} \times \overline{2618HG + 2L^2 + (.J)^2} \times \overline{2618HI} = \overline{2EB^2 \times GI + FA^2 \times HG + CD^2} \times HI \times \cdot2168 = 5855\cdot3142.$

From this whole content then taking the above fum of the deductions, we obtain $3567\cdot5702$ inches; which divided by 282, we have $12\cdot65096$ for the number of gallons required.

	d.	h.	m.	s.
The equal time of the true ☌ at Coventry, april	21	21	17	7
The time of reduction subtract. — —			3	12
Equal time of the true conjunct. of the ecliptick	21	13	55	
The equation of time add. — — —			16	23
The apparent time of the true ☌ — —	21	30	18	
Interval of the true and visible ☌ subt. —			19	57
Interval of the vis. ☌ and greatest ob. sub. —				2
The hourly motion of the ☽ from the ☉ —			35	26
The beginning of the eclipse 22d apr. morn.		8	6	6
The beginning of total obscuration — —		9	9	3
The middle or greatest obscuration — —		9	10	19
The visible conjunction — — —		9	10	21
The end of total obscuration — —		9	11	36
The end or full recovery of sun's light —		10	19	9
The whole duration — — — —		2	13	3

The

* This eclipse was observed in England as here follows.

Places	Observers	Begin.	Immer.	Emers.	Tot.	End.
		h. m. s.	h. m. s.	h. m. s.	m. s.	h. m. s.
Barton	M. Bridges				3 53	
Bell bar	M. Jones	8 6 25	9 9 45	9 13 27	3 42	
Broadway ⎫ Carmarth. ⎭			8 47 0	8 49 30	2 30	10 21 57
Cambridge	M. Cotes			9 14 37		10 24 30
Canterbury	M. Gray	8 10 0				
Chester	M. Ward	7 57 40				10 6 35
Crew	M. Wright		9 2 8		2 0	10 9 0
Dublin	L. Archbish.	7 42 11				9 49 40
Dublin	M. Hawkins	7 41 30				9 48 45
Exon	L. Bishop		8 55 0	8 59 0	4 0	10 0 0
Exon	M. Hudson	7 47 30			3 30	10 0 30
Greenwich	M. Flamsteed				3 11	
King's Wald.	M. Whitside				3 52	
Llanidan ⎫ Anglesey ⎭	M. Rowland	7 52 30				
London	R. Society	8 6 0	9 9 3	9 12 26	3 23	10 20 0
Northamp.	M. Hawkins		9 5 22	9 9 24	4 2	10 15 35
Norton-court	D. Harris	8 8 55	9 13 25	9 14 22	0 59	10 24 47
Oxon	D. Keill				3 30	10 15 10
Plymouth	M. Heines	7 41 0	8 45 30	8 50 0	4 30	9 54 30
Portchester	C. Chandler		9 2 25	9 6 15	3 50	
Salop	D. Hollings	7 58 0			1 40	10 6 0
Upminster	M. Derham	8 7 41	9 10 58	9 14 6	3 8	10 21 45
Wansted	M. Pound	8 6 37	9 9 28	9 12 48	3 20	10 20 32
Weymouth	M. Hobbs		8 53 0	8 58 0	4 0	
Witley	M. Baxter	7 59 0			3 15	10 13 0

The digits eclipfed are 12 d. 10 m. 16 s.

The lat. of the moon feen at the begin. of 20″ fouth afc.

The lat. of the moon feen at the end, of 50″ north afc.*

This eclipfe will be central in the nonagefime degree, in the lat. 59′ 54″ north, and long. eaftward from Coventry 10′ 30″ in the fouth eaft parts of Norway.

The fecond eclipfe is of the moon, on faturday the 7th day of may, half an hour after 1 in the afternoon; fo invifible to us.

The third is a folar eclipfe, falling on funday the 16th day of october, at 11 in the morning.

The fourth is a vifible eclipfe of the moon, monday october the 31ft, at 4 in the morning.*

The

The center of the fhade entered England about Plymouth, and paffed over Exeter, the Devizes, Iflip, Buckingham, and Huntington, leaving Oxford and Bedford on the right, and Lynn on the left, and quitted the coaft of Norfolk about Wells and Blakeney. Its courfe making an angle of 52° 45′ with the meridian eaftwards from the north. And its velocity 29 geographical miles in a minute of time very nearly.

In fome other places it was thus obferved.

Places	Obfervers	Begin.	Greateft Obfcurity	End	Quant. eclipf.
		h. m. s	h. m. s.	h. m. s.	dig. ′
Paris	R. Academy	8 11 c		10 28 c	
Nurenburg				11 10 12	
Hamburg		8 57 0	10 5 30		11 30
Kiel in Hölft.		9 14 0	10 19 20	11 29 c	11 20
Berlin	J. H. Hoffman		10 22 0	11 34 1	11 0
Franckfort		8 50 c	10 0 1	11 10 c	10 34
Pirna	D. Schmiderus	9 15 c	10 30 0	11 32 c	10 0
Dantzick		9 40 2		12 2 40	
Warfaw		9 49 c			
Parma	P. A. Peccadell.	8 45 5		11 0 45	

* This eclipfe was obferved at *Wanfted* by Mr. *J. Pound* thus.

App. time	
h. m. s.	
15 9 c	The eclipfe had been for fome time begun.
16 15 47	The middle.
17 38 20	The end.

The digits eclipfed were 8¾.   The moon's diameter 33′ 40′.

	d.	h.	m.	s.
The equal time of the true oppofition at Coventry, october — — —	30	16	16	31
The time of reduction add. — — —			2	56
The correct time of the true oppofition in the ecliptick — — — — —		16	19	27
Equation of time add. — — —			3	56
The apparent time of the oppofition — —		16	23	23
Interval of the true ☍ and greateſt obſc. s.			5	52
The beginning the 31ſt october, morning —			2 58	29
The middle or greateſt obſcuration — —			4 19	31
The end at — — — — —			5 36	33
The whole duration — — — —			2 38	4

The digits eclipſed 7 d. 51 m. 19 s. nor.

Latitude of ☽ ſouth deſc. at the { beginn. 35 43
{ end 44 25

A type of the lunar eclipſe the 31ſt of october, a quarter after 4 in the morning.
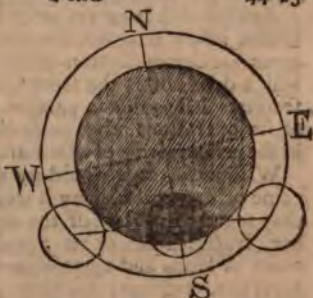
I gave you an account laſt year, that the ſun's eclipſe on the 22d of april, is the greateſt that (I can find) has happened in England theſe 60 years, or perhaps a much longer time, or that will happen for ſo long yet to come. I do not find that anno 1653, was total.

There will be two very large eclipſes of the ſun, one on the 11th of may, 1724, at 6 at night; the other on the 14th of july, 1748, between 10 and 11 in the morning. There will, before the year 1762, be 16 total eclipſes of the moon, and 31 partile eclipſes. As alſo 15 viſible eclipſes of the ſun, 9 of which will be very conſiderable ones; an account of theſe you may meet with in ſome of my next.

Of the excellency and uſefulneſs of Mathematical Learning.

In all ages and countries where learning hath prevail'd, the mathematical ſciences have been looked upon as ſome of

the.

the chief and moſt conſiderable branches of it. And amongſt
the ſeven liberal arts, no leſs than four of them are mathe-
matical; namely, arithmetick, geometry, muſick, and aſtro-
nomy. There is no ſcience in the world, that does improve
the mind of man, ſo much as this; by giving it a habit of
cloſe and demonſtrative reaſoning; by freing it from credu-
lity, prejudice, and ſuperſtition; by rend'ring it exact, and
capable of ſolving the greateſt difficulties; and laſtly, by re-
gulating the imagination, and giving the mind the greateſt
extenſion and capacity that human nature is capable to attain.

The uſefulneſs of this ſcience is almoſt infinite, there be-
ing ſcarce any knowledge, art, or ſcience in the univerſe,
but may be aſſiſted and advanced by it. And indeed it is to
this ſcience we owe the vaſt improvements of natural know-
ledge in theſe laſt ages, and ſome of the moſt noble inven-
tions of the world.

Arithmetick is, an art more liberal than all the reſt, for it
makes ready payment for our diligence, in that it inſtantly
gives the demonſtration of its operations, and ſets no leſſon
which does not at the ſame time diſplay the perfection of its
ſecrets. It has this in particular, That you may find in each
of its operations, that perfection which is vainly ſought for
in the whole circle of other arts.

Without it trade would go near to ruin: What would be-
come of the nation, if by it were not kept the public accounts
that regard the ſtate of the common-wealth, as to the num-
ber, fructification of its people, increaſe of ſtock, improve-
ment of lands and manufactures, ballance of trade, publick
revenues, coinage, military power by ſea and land? Of
which no perſon can truly judge without ſubjecting them to
calculation.

Is it not by this and geometry, that all menſurations of
plains, as board, glaſs, painting, &c. and ſolids, as timber
and ſtone, are performed, and ſold by meaſure as well as
cloth. Workmen are paid the due price of their labour, ac-
cording to the ſuperficial or ſolid meaſure of their work.
And the quantity of liquor determined, for a due regulation
of their price and duty.

By theſe and trigonometry are performed thoſe uſeful parts,
as meaſuring acceſſable and inacceſſible heights and diſtances
by ſea and land, laying down plans of particular lordſhips,
incloſures, and taking maps of countries. What fortifying,
attacking, defending, bombing, mineing, or quartering and
embatailing of armies, could be performed without the aſ-
ſiſtance of arithmetick and geometry? How is it but by theſe
arts, that building of houſes and ſhips, the making of teleſ-
copes, microſcopes, ſpectacles, and all other optick glaſſes;
the calculating of clocks, watches, and ſun-dials, and all
<div align="right">mechanick</div>

mechanic engines and inftruments, are demonftrated and made?

Nor is its ufe lefs inferior by fea in the art of navigation, on which the riches and fecurity of the kingdom depend. How vain and unfuccefsful would the merchant's pretenfions be to fetch home riches from any part of the world? Could the navigator ever hope to find his way (after a ftorm) by fea, without the help of aftronomy, to know longitude and latitude, by the fun, moon, and ftars, and the other planets and their fatellites in the obfervation of their diftances, oppofitions, conjunctions, eclipfes, rifing, fetting, culminating, &c.

Our ignorance of the ebbing and flowing of the tides would argue a want of aftronomy, as alfo the times and feafons of the year, the obfervation of the feftivals and fafts of the church, according to the firft primitive inftitution, could not be kept to a due difpofition, as to the return of the feafons and the fun's motion.

Nothing furely can more illuftrate and give greater life and glory to aftronomy, and animate its profeffors, than the generous encouragement her late facred majefty and parliament have now been pleafed to give, by fettling a reward of twenty thoufand pounds, on fuch perfon or perfons as fhall difcover a more certain and practicable method of afcertaining the longitude, than any yet in practice. And although aftronomy is in thefe days arrived to a great perfection, yet are there (I doubt) wanting a long feries of obfervations of the heavenly bodies, to effect the fame.

It was the opinion of fome about 1630, that longitude might be found by the obfervation of fomething below the moon. In purfuance whereof, Mr. *Henry Bond*, a mathematician, after 38 years ftudy and obfervation in 1676, publifhes a treatife, entituled, *Longitude found, by the magnetick inclinatory needle;* which was by his majefty's appointment examined by fix commiffioners, celebrated men of their time, *viz*. Seth, Lord Bifhop of Sarum, the Lord Brunker, Sir Samuel Morland, Col. Titus, Dr. Pell, and Mr. Hook; and was farther confirmed by feveral obfervations in the ftreights of Magellan; for encouragement of which, his majefty king Charles II. was gracioufly pleafed to grant his royal licence for publifhing the fame, with privilege for 15 years, dated 28th june, 1676. But it feems this fell fhort of its end, as all the methods of our modern pretenders to longitude have yet done. I heartily wifh it may be the glory of our age to find the fame.

But as 'tis needlefs to fay thus much of a fcience that illuftrates its ufes and perfections daily, I can but admire who would be ignorant of its excellency, ufe, and benefit to

mankind.

mankind? Who would not take fome pains, to attain a com-
petent knowledge of an art fo truly valuable? I am confident
there is no thoughtful and contemplative perfon but would
find pleafure and fatisfaction in the ftudy of it. 'Twas from
thefe confiderations, that in my vacant hours I have (tho'
meanly) endeavoured to introduce fome parts of it into the
world, by the enfuing method.

Some Paradoxes propofed, to be anfwered next year.

A paradox is a feeming falfity, but a real truth; it is that
which to unthinking perfons feems abfurd, or impoffible,
but to a thoughtful man is plain and evident; the main drift
whereof is to whet the appetite of an inquifitive learner, and
fet him upon thinking. Although (fays an ingenious author)
the foul of man is a cogitating being, and its thoughts fo
nimble as to furround the univerfe itfelf in a trice; yet fo
unthoughtful, and ftrangely immur'd in fenfe, are the ge-
nerality of perfons, that they need fome ftartling noife to
roufe and awake them.

The propofing a paradoxial truth to the intellect, immedi-
ately fummons all the powers of the foul together, and
fets the underftanding on work to fearch into, and fcan the
matter. 'Tis no trivial bufinefs to awaken the mind of man
to its natural act of thought and confideration. If therefore
thefe enfuing paradoxes fhall obtain this end, it matters the
lefs if fome of them, upon ftrict enquiry, fhould be found to
confift of equivocal terms, or perhaps prove little more than
a quibble at the bottom.

1. A Paradox by Mr. Moyle.

Chriftians the week's firft day for fabbath hold;
The jews the feventh day (as they did of old);
The turks the fixth (as I have been told).
Now, good fir, pray tell to me,
How it is poffible this thing can be,
That ever a chriftian, jew, and turk, thefe three
Being all together in one place, may,
In and upon one and the felf-fame day,
Have each his own true fabbath? tell, I pray.

Some Geographical Paradoxes from an ingenious author:

Par. 2. There is a particular place of the earth, where
the winds (tho' frequently veering round the compafs) do
always blo from the north point.

Par

Par. 3. There is a certain hill in the fouth of Bohemia, on whofe top, if an equinoctial fun-dial be duly erected, a man that is ftone blind may know the hour of the day by the fame, if the fun fhines.

Par. 4. There is a vaft country in Ethiopia fuperior to whofe inhabitants the body of the moon doth always appear to be moft enlighten'd when fhe's leaft enlighten'd; and to be leaft when moft.

Par. 5. There's a large and fpacious plain in a certain country in Afia, able to contain fix hundred thoufand men drawn up in battle array; which number of men being actually brought thither, and there drawn up, it was abfolutely impoffible for any more than one fingle perfon to ftand upright upon the faid plain.

Par. 6. There are three diftinct places on the continent of Europe, equidiftant from one another, (they making a true equilateral triangle, each of whofe fides doth confift of a thoufand miles) and yet there is a fourth place fo fituated in refpect of the other three, that a man may travel on foot from it to any of the other three, in the fpace of one artificial day at a certain time of the year, and that without the leaft hurry or fatigue whatfoever.

New Queftions.

I. *Queftion* 41, *by Mr.* Dod.

A rakifh fpark the other night,
    (Who had learn'd fome algebra)
Came home half drunk, as well he might,
    From tippling all the day.
His uncle chid him, and complain'd,
    He'd run thro' his eftate,
And afk'd what he that day did fpend;
    To which he anfwer'd ftreight,
The pence fquar'd and involv'd into
    Five times their own fquare root,
Are pounds one hundred fixty-two,
    Whence you may find it out.

II. *Queftion* 42, *by Mr.* William Taylor.

As I was walking out one day,
Which happ'ned on the firft of may,
As chance would have it, I did fpy
A may-pole raifed up on high,
The which at firft me much furpriz'd,
Not being before-hand advertiz'd

Of

Of such a strange uncommon sight,
I swore I would not stir that night,
Nor rest content until I'd found
Its height exact from off the ground:
But when these words I just had spoke,
A blast of wind the may-pole broke;
Whose broken piece I found to be
Exact in length yards sixty three;
Which by its fall broke up a hole,
Twice fifteen yards from off the pole;
But this being all that I can do,
The may-pole now being broke in two
Unequal parts: To aid a friend,
Ye ladies, pray an answer send.

III. *Question* 43, *by* Mrs. Boydell.

An aged fire, with his two daughters, came
To town, and was desir'd to tell his name.
My name, says he, 's a thousand more than you,
And I, and if you add the other two,
The number of this present year they'll shew.
The * numr'al letters of our names (well set
With the first letter of the alphabet)
Make seventeen hundred, and fourteen compleat.
I'll further add (to make the problem plain)
Each single name five letters doth contain.

* D. *stands for* 500, C. *for* 100, L. *for* 50, V. *for* 5, I. *for* 1, &c.

IV. *Question* 44, *by* Mr. T. Hayward.

Within my garden, lying on the ground,
A stone I've got, that weighs 300 pound;
A little barrow likewise, six foot long,
I've got; tho' little, it is very strong.
Now, firs, because the stone lay in my way,
I sold it to a mason yesterday;
Who begg'd my barrow for to take it home,
And call'd his two men; presently they come;
But one (being lately sick) was very weak,
More than five score he could not undertake.
How on the barrow must this stone be laid?
Pray tell me; for this fellow is afraid,
If he should carry much, 'twould do him more
Diskindness, than his sickness did before.

V. *Queſtion* 45, *by Mr.* Tho. Shepheard.

Suppoſe the earthly ball's circumference
Be one and twenty thouſand miles in length,
Beſides ſix hundred more.　I fain would know
How far the head of any one doth go
More than his feet; (but yet I muſt diſplay
The matter more, or you'll not find the way.)
One that's five foot and ſeven inches tall,
To go in length upon this earthly ball
Ten thouſand miles exactly: That is all.

VI. *Queſtion* 46, *by Mr.* Ed. Elphick.

Kind ſir, I pray, can you to me declare
A lofty tower's height within the air:
I'll tell you how the height you well may know,
Which in a problem unto you I'll ſhow.
　If from the tower's height there ſhould be laid
A plain, whoſe ſurface fine and ſmooth is made,
To meet the earth; three hundred foot and four
From the foundation of this lofty tower;
And then a body which in pounds doth weigh
Juſt fifty ſix, you on the plain do lay;
Juſt forty pounds will the ſame ſuſtain,
From ſliding down on this deſcending plain.
But, artiſt, I apply myſelf to you,
(The tower's height) to calculate it true.

The Prize Queſtion.

When Phœbus had up-heav'd his golden head,
From the ſoft pillow of his ſea-green bed,
And with his riſing glory had poſſeſt
The ſpacious borders of th' enlighten'd eaſt:
　In Albion's channel, off from the cliffs of Dover,
Where I could ſcan that famous channel over,
And make bright Callis ſhining in the eaſt,
Our ſhip then lying almoſt pointing weſt;
The day ſerene and fit for obſervation,
I ſent a ſhip to form a ſecond ſtation:
Then I obſerv'd my angles for to be
* Twenty four and eighty ſix degree;
And at my ſecond I the object ſees,
At † forty eight, a hundred twenty nine degrees.

　　　　* 24° *and* 86°.　† 48° *and* 129°.

This

This being known, How far's each ship's from th' other?
Likewife, how far off Callis and off Dover?
But e'er the cafe determin'd will appear,
The following lines to you I muft declare.
 Being on Dover's beach an object I efpy'd,
Which on a wave from Callis bank did glide.
In equal times it equal fpaces run,
From whence its rapid motion firft begun.
Forty five foot was each wave's true diftance,
And in a line approaching me did dance:
* Two hours, twenty five minutes, ten feconds more,
Ten thirds, thirty three fourths (the wave did roar)
And thirty fix fifths, is the true time I found,
From my firft fight to's breaking on the ground;
Which was the place I ftood upon.
Now I would know how far the diftance run.
Which being known (what undetermin'd were)
If rightly managed) true proportion bear.

   * $2h.\ 25'\ 10''\ 10'''\ 33''''\ 36'''''$.

1716.

Anfwers to the Paradoxes propofed laft year.

Anna Philomathes *anfwer'd them all*. *To the firft thus :*

FROM the place o'th' jews abode let the other two fet out,
 The chriftian eaft, the turk weft, and fail the globe about,
Then with the jew they'll agree when they again do meet,
And all upon the faturday will their true fabbaths keep.

  Paradox 2d *anfwered, the* South Pole.

Paradox 3d. If a burning glafs be the nodus of a dial, and
fo contriv'd that the focus may fall on an iron or brafs plate
or ring, on which the figures are deeply cut, a blind man
may feel where the plate or ring is heated by the fun, and
which figure it is upon or neareft to.

 To the 4th paradox the ingenious Anna Philomathes *thus
anfwers :* The light that falls upon any body, being always
in a reciprocal duplicate ratio of the diftance from the lumi-
nous body : hence it follows, that not only in Ethiopia, but
in all parts of the world the moon doth always appear to be
moft enlightned, at the full moon, when fhe's leaft enlight-
ned, becaufe fhe is then removed from the fun farther than
at the new moon, by the diameter of the moon's orbit.

              The

The 5th paradox anfwered, according to Euclid. A plane can touch a fphere only in one point, call'd the contact, and that perfon only who ftands to that point (with refpect to the center of that fphere) can ftand upright.

The 6th paradox anfwer'd. By an artificial day is here meant from fun-rifing to fetting. And beyond the tropick, and nearer and nearer the poles, the days are increas'd when the fun comes on that fide the equator from 24 hours long to about 100 days long, the fun neither rifing nor fetting in that fpace of time.

Mr. *Moyle* anfwer'd 2, 4, 5, 6; Mr. *Edens,* all; *Paftora,* the firft. Mr. *B. Graves,* 1, 2, 5. Mr. *Andrew,* 2, 5, 6. *John Hodge,* all. Mr. *Walker,* 2, 6. Mr. *Wylde,* 2, 6. Mr. *Coles,* 1. Mr. *Wentworth,* 2, 6. Mr. *Afh,* 1. *Tho. Andrew,* 3, 6. *Tho. Coach,* 5, 6. *I. Richards,* 1, 2, 5. *R. Hall,* 1, 2. and *Cynthia Aris,* the firft.

Solutions to the laft year's queftions.

* I. *Queftion* 41, *anfwered by* Mr. Richard Sandford.

> Well might his uncle blame the rakifh fot,
> For fpending thus three fhillings at a fhot;
> Sure he'll no longer trifle time away,
> But fpend lefs in ale, more in algebra.

The fame anfwer'd by Silvia.

> Your algebraick, tipling fpark,
> Might well reel home, when in the dark;
> I'll fwear he was a learned blade,
> And has a learned reck'ning made:
> 'Mongft pot companions he's no fool,
> Who fcores by fcale, and drinks by rule;
> But to prevent his uncle's lofs,
> I here explain the tippler's dofe.   *Anf.* 36 *pence.*

If the pence in 162 pound be b, and the pence fpent be $= a$; then this theorem folves the queftion $a = \sqrt{\dfrac{b^2}{25}} = 36.$

II. *Quef-*

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* I. QUESTION 41. *folved.*

Let x denote the pence fpent. Then, by the queftion $x^2 \times 5\sqrt{x} = 162 \times 240 = 38880$, or $x^2 \sqrt{x} = 7776$; hence, by fquaring, $x^4 \times x$ or $x^5 = 7776^2$; and confequently $x = 7776^{\frac{2}{5}} = 36$ d. $= 3$ s.

* II. *Queſtion* 42*d*, *anſwered by Mr.* Joſ. Jeacock.

To aid a friend, I here intend,
 The may-pole's height to ſhow,
So if you pleaſe, you may with eaſe
 Thus view it here below.   *Anſ.* 118·3985 *yards.*

This is found by the 47*th theorem of* 1 *lib. Euclid.*

III. *Queſtion* 43, *anſwered by* Philo Tipperus, *and Mr.*
P. Profon.

Whilſt Lidia for Lydai you cunningly write,
 You think you may ſurely enſnare us;   *David* 1006
But David is aged, and Lucia bright,   *Lidia* 552
 So 'tis eaſy to——Philo Tipperus   *Lucia* 156
The daughters who to town with David came,
Lucia was one, and Lidia's t'other's name. *P. Profon.* 1714

IV. *Queſtion* 44, *anſwered by* Silvia.

To eaſe the maſon's feeble man by true mechanick ſkill,
The ſtone upon the barrow plan thus to be plac'd I will;
Of gravity the center lay, juſt ſo much next the ſtronger,
That diſtance 'twixt the other may be two to one the longer.

In queſtions of this nature the reſult will be; the greater
ſtrength multiply'd by the ſhorter length, is equal to the
leſſer ſtrength multiply'd by the greateſt length; and here
the barrow's weight is not accounted for, otherwiſe it would
require ſome ſkill in ſtaticks to reſolve it.

V. *Queſtion* 45, *anſwered by* Silvia.

Your thought is odd, but juſt, the caſe is plain,
 Our heads in haſte, outſtrip our heels;
And what in miles ten thouſand thus they gain,
 (Unleſs the man be drunk or reels)
 Without the help of magick or a ſpell,
 In arithmetick numbers, I will tell.

'Tis

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* II. QUESTION 42. *ſolved.*

It is evident, from the queſtion, that the part broken off (63)
is the hypothenuſe of a right-angled triangle, whoſe perpendicular
is the part left ſtanding, and baſe equal to (30) the given diſtance
which the top ſtruck the ground from the pole; and conſequently,
by right-angled triangles, $\sqrt{63^2 - 30^2} = \sqrt{3069} = 55\cdot3985559$
= *the part left* ſtanding. To this adding 63 the part broken off,
we obtain 118·3985559 for the whole length required.

'Tis evident in the cafe propofed, that while the feet de-
fcribe an arch on the earth's furface equal to 10000 miles, the
head will defcribe a fimilar arch of a circle, whofe radius
exceeds the femi-diameter of the earth 5 feet 7 inches:
Therefore as the femi-diameter of the earth, is to the femi-
diameter increafed by 5 feet 7 inches: So is 10000 geogra-
phical miles, to an arch exceeding 10000 miles by 16·23 feet,
according to *Van Culen*'s proportion of the diameter to the
circumference, viz. as 1 to 3·141592653589793.*

VI. *The 46th Queftion anfwered by the fame, and Mr.* James
Cole, *Mr.* Doidge, *Mr.* Edens, *Mr.* Willingham, *Mr.*
Ronkfley, *Mr.* Wylde, Anna Philomatha, *Mr.* Richards,
Mr. Bower, *&c.*

> Your tower's lofty and fublime,
> Your problem rational and fine,
> Your method's juft, I like the notion,
> Which joins with numbers, weight, and motion;
> But fure it is contriv'd to vex
> Our uninftructed, fofter fex:
> You try our weaknefs, fearch out flaws,
> By algebra and ftatick laws;
> Yet to untie your curious knot,
> Since 'tis a homely virgin's lot,
> Pleafe to accept my kind, officious aid,
> Who am a rural and mechanic maid.

By a known principle in mechanicks, the accelerating ve-
locity, or weight of bodies on an inclin'd plane, is to their
accelerating velocities or weight in their perpendicular de-
fcent, as the fign of the angle of inclination, to the radius:
or as the perpendicular to the length of the plane, confider'd
as an hypothenufe; and therefore in this the proportion of
                                                        the

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* V. Q U E S T I O N 45. *folved.*

Since the earth's radius is $\dfrac{21600}{2 \times 3\cdot14159 \ \&c.}$ inches, and 5 feet

7 inches $= 67$ inches; by fimilar fectors, as radius : radius $+ 67$
:: 10000 : 10000 $+$ the excefs travelled by the head; or, by di-
vifion, as radius : 67 :: 10000 : the faid excefs; that is, as

$$\frac{21600}{2 \times 3\cdot14159 \ \&c.} : 67 :: 10000 : \frac{10000 \times 67 \times 2 \times 3\cdot14159 \ \&c.}{21600}$$

$$= \frac{6700 \times 3\cdot14159 \ \&c.}{108} = 194\cdot8951 \text{ inches} = 16\cdot2412 \text{ feet} = \text{the}$$

excefs required.

Mathem.   M

the perpendicular, and the length of the plane, being given
as 40 to 56, or as 1 to 1·4. Let the perp. fought be $= x$,
the hypothenufe will be 1·4 x, and the bafe 304 feet $= a$,
then, 1·96 $x^2 - x^2 = 0.96 x^2 = a^2$ by 47 Euclid 7. and by
divifion and evolution.

$$x = \overline{\frac{aa}{0.96}}\Big|^{\frac{1}{2}} = 310.27 \text{ feet required.*}$$

Here follows the anfwers of two ingenious perfons to all the
6 queftions, in one copy of verfes.

Mr. C. Mafon, *from Northumberland.*

The rakifh fpark three fhillings fpent,	*Queft.* 41.
If that I took it right ;	
Which having done, he fwagg'ring went,	
And took the may-pole's height ;	
Which was in yards, fivefcore eighteen,	42.
And nigh four-tenths, I fay ;	
But David the like ne'er had feen,	43.
Lydia nor Lucia.	
Then take one-third o'th' barrow's length,	44.
And thereon lay the weight,	
'Caufe the one exceeds a third in ftrength,	
'Twill counterpoize them right :	
Then fixteen feet one quarter more,	45.
Let them bear it away,	
Or feet three hundred and ten, fome o'er	46.
They there may let it ftay.	

Mr. *Fran. Walker*, of Lynn, in this method anfwer'd all
fix; as did Mr. *Ambrofe Gilbert*, except the 46th queftion.
I am.

---

* VI. QUESTION 46. *folved.*

It is evident that this problem may may be eafily *Conftructed*
thus : Make a right-angled triangle whofe hypothenufe and per-
pendicular are 56 and 40, or 7 and 5, or any two numbers pro-
portional to thefe ; then make another fimilar triangle whofe bafe
may be 304; and its perpendicular will be the height of the caftle
required:

And from the fame principle, the *Calculation* may be given with-
out algebra, thus : Since $\sqrt{7^2 - 5^2} = \sqrt{24} =$ the bafe of the
firft triangle to which the other is fimilar, we fhall have as $\sqrt{24}$: 5
:: 304 : $\dfrac{304 \times 5}{\sqrt{24}} = \dfrac{304}{\sqrt{.96}} = \dfrac{760}{\sqrt{6}} = 310.2687 =$ the caftle's
height.

I am forry no other perfons that have truly anfwer'd them fingly, would take the pains to put their anfwers into one fhort copy that might have had a place here.

The Prize Queſtion anſwered.*

To this queſtion, befides abundance of falfe anfwers, I received ten true ones, and becaufe I fee fo few amongſt fo many ingenious correfpondents, I am apt to believe it was as difficult, as 'twas an uncommon queſtion; for which reafon I fhall here give you the folution, and the algebraick method by which the fame is found.

Sir *Iſaac Newton*, in his *Principia*, fays, Let there be a pendulum, whofe length from the point of fufpenfion, to the center of obfcillation, is the breadth of any wave; then while the pendulum makes an obfcillation, the wave will pafs over a diſtance equal to its breadth. From which, and the nature of pendulums, is raifed the following theorem.
Let

---

* The PRIZE QUESTION ſolved.

Perhaps the folution will appear a little clearer thus : Put $p =$ 39·2 inches the length of the pendulum, $v = 60$ the number of vibrations it makes in a minute, $b = 45$ feet the breadth of a wave, and $t = 145\cdot1696$ minutes the given time. Then, by the nature

of pendulums, $\sqrt{12\,b} : \sqrt{p} :: v : v\sqrt{\dfrac{p}{12\,b}} =$ the number of vi-

brations made in a minute by the pendulum whofe length is the breadth of a wave ; but for every vibration the wave will pafs over a diſtance equal to its breadth b; hence the wave moves over

$b v \sqrt{\dfrac{p}{12\,b}}$ or $v\sqrt{\dfrac{b\,p}{12}}$ feet in each min. which therefore drawn into

t minutes makes $t v \sqrt{\dfrac{b\,p}{12}} = t v \sqrt{\dfrac{45 \times 39\cdot2}{12}} = t v \sqrt{15 \times 9\cdot8} =$

$7 t v \sqrt{3} = 145\cdot1696 \times 420\sqrt{3} = 105605\cdot2$ feet $=$ 20 miles nearly $=$ the diſtance between Calais and Dover.

This diſtance being obtained, which is the fide *C D* of a quadrilateral *A B C D*, of which the angles formed by the oppofite fide *A B* with the two diagonals *B D*, *A C*, as alfo with the other two fides *A D*, *B C*, being given, the figure will be *Conſtruĉted* (as in the Britiſh Oracle) thus :

At the extremities *A*, *b*, of any line *A b*, make the angles *b A c*, *b A d*, *A b c*, *A b d* equal to the given angles, and join *c*, *d* ; fo fhall *A b c d* evidently be a quadrilateral fimilar to *that* formed by the two towns and two fhips ; and, confequently, if *d c* be produced to *E*, till *d E* be equal to 20 the given diſtance between Calais and Dover.

and

Let the diftance run be $= a$, the length of a ftandard pendulum $= p = 39'2$ inches; the fquare of the vibrations in a minute $= f = 3600$, $s = 45$ feet or 540 inches, the breadth of the wave, and $t = 2$ hours 25 min. &c. $= 145'1696$ minutes,

alfo $r = 45$ feet: then $s : p :: f : \frac{pf}{s}$; but $\sqrt{\frac{fp}{s}} =$ to the number of vibrations it will make in a minute, and multiplied by r will be the feet the wave will move in a minute;

but $\dfrac{a}{r\sqrt{\frac{pf}{s}}} = t$, and confequently, by reduction, $a =$

$r t \sqrt{\dfrac{pf}{s}} = 105600$ feet $= 20$ miles fought, or the diftance from Calais to Dover.

In this following figure C reprefents Calais, D Dover, A the firft fhip, B the fecond.

Then

From {
Cal. to Dov. C to D 20 mil.
Dov. to 1ft fh. BA 13'5192
Dov. to 2d fh. DB 18'1583
Cal. to 1ft fh. CA 22'4008
Cal. to 2d fh. CB 11'7238
1ft fh. to 2d fh. AB 15'0853
}
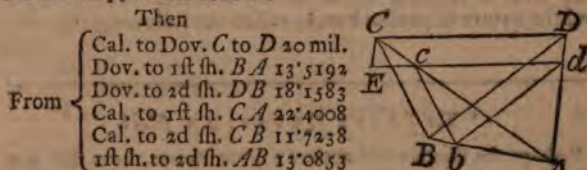
The angles DAB 86°, CAB 24°, DBA 48°, CBA 129°.

Mr. *William Hawney*, (who won the prize of 10 diaries) Mr. *John Edens*, A. *Philomathes*, Mr. *James Moufe*, Mr. *Stephens*,

---

and EC be drawn parallel to Ad and meeting Ae in C, that then CB, CD being drawn parallel to cb, cd, and meeting Ab, Ad in B and D, the points A, B will be the two fhips, C Calais, and D Dover.

The *Calculation* from this conftruction is alfo evident: viz. affuming $Ab =$ any number, as fuppofe 10, in the two triangles Abc, Abd, we have given all the angles and the fide Ab, to find the other fides; and hence thofe fides are $Ac = 17'11811$ miles, $be = 8'95914$ miles, $Ad = 10'33093$ miles, and $bd = 13'86777$ miles. Then in the triangle bcd are given two fides with their included angle, to find the third fide cd, which will be $= 15'28859$ miles. Laftly, by fimilar triangles, as $cd = 15'28859 : CD = 20$

$::$ {
$Ab = 10$ $: AB = 13'08165,$
$Ac = 17'11811 : AC = 22'39331,$
$Ad = 10'33093 : AD = 13'51456,$
$bc = 8'959144 : BC = 11'72004,$
$bd = 13'86777 : BD = 18'74133.$
}

Stephens, Mr. *Stewart*, *T. W.* Mr. *James Pearse*, and Mr. *Cha. Bower* anfwer'd this queftion, as alfo Mrs. *Mary Nelfon* in the following verfe :

Mafter Tar, I proteft I'm not pleas'd with your query,
You've fent at this time to be folv'd in your diary,
Methinks it looks like an ill-natur'd demand,
To offer to puzzle us ladies at land;
Tho' I'm apt to believe, if a trial fhould be,
That you'd puzzle us worfe if yo u had us at fea :
But methinks I can guefs how you fparks are inclin'd,
You are always beft pleas'd when the ladies prove kind;
Then to fhew that we maids of this brave Britifh nation,
Can act here at land, or at fea on occafion,
To each of your queries I've fent you an anfwer,
And all of them right, then deny't if you can, Sir.
(*Here follow'd the anfwer.*)

Of the Perfection of Aftronomy.

Having laft year faid a word or two of the mathematics in general, I fhall here handle them gradually : but as aftronomy is the moft noble and fublime of all the parts, I fhall at prefent confine myfelf to fay fomething of it. In which let us confider, to what perfection we now know the courfes, periods, orders, diftances, and proportions of the heavenly bodies, at leaft fuch as fall within our view. We fhall have caufe to admire the fagacity and induftry of the mathematicians, and the power of numbers and geometry well applied : if we caft our eyes backwards, and confider aftronomy in its infancy, what a mean and inconfiderable figure did it make, to what it does in our days?

Let us fuppofe (faith an ingenious author) a colony of rude country people tranfplanted into an ifland, remote from the commerce of all mankind, without fo much as the knowledge of the calendar, and the periods of the feafons; without inftruments to make obfervations, or the leaft notion of them. When is it we could expect any of their pofterity fhould arrive at the art of predicting an eclipfe? Not only fo, but the art of reckoning all eclipfes that are paft or to come, for any number of years? When is it we could fuppofe, that one of thofe iflanders, tranfported to any place of the earth, fhould be able, by the infpection of the heavens, to find how much he were fouth or north, eaft or weft of his own ifland, and to conduct his fhip back thither? For my part, though I know this may be, and is daily done, by what is known in aftronomy, yet when I confider the vaft induftry, fagacity, multitude of obfervations, and other intrinfick things neceffary

fary for fuch a fublime piece of knowledge, I fhould be apt
to pronounce it impoffible, and never to be hoped for.

Now we are let fo much into the knowledge of the ma-
chine of the univerfe, and motion of its parts, by the rules
of this fcience, perhaps the invention may feem eafy. But
when we reflect, what penetration and contrivance were ne-
ceffary to lay the foundation of fo great and extenfive an
art, we cannot but admire its firft inventors: fuch as *Thales
Milefius*, who predicted eclipfes, and his fcholar *Anaximan-
der Anilefius*, who found out the globous figure of the earth,
the equinoctial points, the obliquity of the ecliptick, the
principles of gnomonics, and made the firft fphere, or image
of the heavens; and to *Pythagoras*, to whom we owe the
difcovery of the true fyftem of the world, and the order of
the planets: tho' it may be they were affifted by the Egyp-
tians and Chaldeans. But whoever they were that firft made
thefe bold fteps in this noble art, they deferve the praife
and admiration of all future ages.

Altho' the induftry of former ages had (as I faid before)
difcovered the periods of the great bodies of the univerfe,
and the true fyftem and order of them, and their orbits
pretty near; yet were they very deficient in divers things.

The one was in the true calculations of eclipfes; for the
beft of them miftook egregioufly in them, making eclipfes
when really there was none, and omitting them many times
when the luminaries were really obfcur'd; and when they
with difficulty hit upon the time pretty near, they were of-
ten out in the digits eclipfed, and fometimes making one fide
of the fun or moon dark, when really it proved to be the
other. But the aftronomers of our age have arrived at much
greater perfection, efpecially in the fun's eclipfe (witnefs that
great one laft year) which is much more difficult than that
of the moon; for an eclipfe of the moon has the fame ap-
pearance to all its beholders; whereas that of the fun may
appear to one part of the earth totally eclipfed, to another
part of the earth eclips'd but in part on its north fide, to
others eclips'd in part on its fouth fide, and to others not
eclips'd at all; and all this at the fame moment of time.
So that an eclipfe of the fun muft be calculated for e-
every individual place, if you have its true appearance,
which caufes it to be fo difficult to perform, and made the
ancients to err fo very much in that particular. As an in-
ftance of our modern improvements, I will give you the cal-
culations of two great eclipfes of the fun, which are the
greateft that will happen in our ifland thefe 50 years; yet to
come, and tho' they happen not for feveral years, I doubt
not but they that obferve them, will find them exactly at
the time here fet down. They are calculated for the latitude
of

of 52 deg. 30 min. and longitude 1 deg. 30 min. West from London, being the city of Coventry. The first is on the 11th of May, 1724, the second on July 14, 1748, calculated from Mr. *Street's Astronomia Carolina.*

	May 11, 1724, in the evening.			14 july, 1748, m.		
	h.	m.	s.	h.	m.	s.
The apparent time of the true ☌	5	17	3	11	16	38
The interval of true and visible ☌	1	17	13 fub.	0	39	14
The visible ☌ — — —	6	34	16	10	37	24
Interval of vif. ☌ and greatest obf.	0	0	16 ad.	0	0	54
The beginning — — —	5	38	9	9.	8	12
The middle — — —	6	34	0	10	38	18
The end — — — —	7	26	25	12	12	30
The whole duration — —	1	48	16	3	14	18
Digits eclipfed — —	So. 11	31	40	No. 10	16	13
Latitude of ☽ at beginning	1′ 45″ S. D.			7′ 18″ N. D.		
Latitude of ☽ at ending	2 11. S. D.			3 13 S. D.		

1724

1748

On february 18, 1737, happens a great eclipfe, but lefs than either of thefe two, being eclipfed digits 10 d. 5 m. The middle at 46 min. after 3 in the afternoon.

Tho' the induftry of the ancients was very great, and the improvements of the latter days very confiderable, yet was there one thing ftill referv'd for the glory of this age, and the honour of the Englifh nation, the grand fecret of the whole machine; which now it is difcover'd, proves to be (like the other contrivances of infinite wifdom) fimple and natural, depending upon the moft known and moft common property of matter, namely, gravity. From this the incomparable Sir *Ifaac Newton* has demonftrated the theories of all the bodies of the folar fyftem, of all the primary planets, and their fatellites, and among others, the moon, which feem'd moft averfe to numbers, and the comets alfo, whofe revolutions fpend more than 2000 years about the fun. A wonderful difcovery! fcarce ever to be hoped for by the boldeft thinker.

Observations on the great Eclipses.

The great folar eclipfe on the 22d of april laft year, being by fo many hands calculated, and there appearing fo great a difference in the time of the eclipfe's happening, amongft thofe calculations; aud feeing each one fo fond of his tables, or of thofe he ufes, thereby to leffen the efteem, if poffible, ingenious men bear to the Caroline tables; I have endeavoured to get what obfervatiohs of that eclipfe I could, from feveral ingenious men, to prove which tables folved this phænomenon exacteft. And forafmuch as the calculation in the ladies' diary laft year was for London, tho' by miftake faid to be for Coventry, I have taken the pains to calculate that famous eclipfe again, and all along to compare it with what others have done, and do affure you, the refult in the next fide is the true calculation from the fecond edition of *Street*'s tables. And that many others who calculated the fame by thofe tables, have not come within 8, 10, or 12 min. of the true time, is occafioned, as I conceive, by miftaking that author as to the abfolute equation of time, in page 83, making it about 3″ 13″ inftead of 16′ 23″, differing above 13′ in that particular. Nor do I find any who have calculated by Mr. *John Wing*'s *Scientia Stellarum*, come near to obfervation unlefs himfelf, which, and that he did from Mr. *Shakerley*'s tables, are the two beft I have met with, except the great Dr. *Halley*'s, and the indefatigable M. *Flamftead*'s.

But what is more obfervable, fcarce any one of them make it total, tho' calculated for near the path of the moon's center, or come near the true digits eclipfed, befides thofe from the Caroline tables; for my part I could never find it otherwife than total, even in London.

And becaufe nothing but good obfervation can help us to improve our future calculations, I have fubjoin'd fome as I receiv'd them, the 4th, 5th, 7th, 9th, 10th, 11th; and 12th, were communicated to me by my worthy friend the Rev. Mr. *Wright*, of Crew, in Chefhire, whofe accurate obfervations and fkill in the jovial ftronomy will (I doubt not) much advance it. The firft was fent me by my ingenious countryman Mr. *John Edens*, from Teneriffe, one of the Canary iflands, taken on board, in the latitude 34° 20′ N. longitude 13° 20′ weft from London. And laftly, becaufe the eclipfe of the moon the 31ft of october, 1715, by miftake of the printer, had its type revers'd, I have again inferted a new calculation from *Aftronomia Carolina*.

Observations.	Begin. h. m.	Immer. h. m.	Emerf. h. m.	End h. m.
Canaries, by Mr. Edens	6 49	digits	ecl. 9	8 47
Dublin	7 47			9 51
Exeter, by Mr. Richards		8 52	8 56	
Chester, by Mr. Ward	7 57¾			10 6½
Crew, in Cheshire, by the Rev. Mr. Wright	7 59	9 2⅛	9 4	10 9
Worcester		8 38½	9 2¼	10 9½
Oxon		9 4½	9 8	10 14½
London	8 6½	9 9½	9 12¾	10 20¼
Wansteed, Essex, Mr Pounds	8 6½	9 9½	9 12¾	10 20½
Upminster, by Mr. Derham	8 7¾	9 11	9 14	10 21½
Ladsdown, in Kent, by the Rev. Mr. Thornton	8 7¼	9 10½	9 13¼	10 22
Feversham, by Mr. Gray	8 9	9 13½	9 14½	10 24½
Lydd, by Mr. Hawney	8 9	not	total	10 23

The calculation of the sun's eclipse, the 22d of april last.

	h. m. s.	
The apparent time of true ☌	9 26 21	At Coventry, by *Astronomia Caro-lina*, in the morning.
The visible ☌ at —	9 5 19	
The beginning — —	8 1 40	
The end — —	10 15 49	
The whole duration —	2 14 8	
The digits eclipsed 12° 8′.		

The moon's eclipse on the 31st of october next, 1715, at London, happens the beginning 55 min. past 2 in the morning; greatest obscuration is at 15 min. past 4, the end 35 min. after 5, the whole duration 2 ho. 39 min. and digits eclipsed 7° 56′.

In this year, 1716, on the 11th day of april, the sun will be eclipsed about two in the morning, and therefore not visible; and on october the 4th invisible: of which eclipses, had I room to insert the calculations, they would be useless, excepting to the countries where visible.

Paradoxes to be anſwer'd next year, from an ingenious author.

Par. 1. There is a conſiderable number of places lying within the torrid zone, in any of which, if a certain kind of ſun-dial be duly erected, the ſhadow will go back ſeveral degrees upon the ſame, at a certain time of the year, and that twice every day for the ſpace of divers weeks; yet no ways derogating from that miraculous returning of the ſhadow upon the dial of Ahaz, in the days of king Hezekiah.

Par. 2. There are two diſtinct places of the earth lying under the ſame meridian, whoſe difference of latitude is 60 degrees compleatly, and yet the true diſtance between thoſe two places doth not really ſurpaſs 60 Italian miles.

Par. 3. There is a certain noted part of the earth, where the ſun and moon [ipſo tempore plenilunii] may both happen to riſe at the ſame inſtant of time, and on the ſame point of the compaſs.

Par. 4, *by* Heſychia.

I have 12 times ſeen the biſſextile, pray tell how that can be?
Since 12 times 4 make 48, and I'm but forty-three.

New Queſtions.

I. *Queſtion* 47, *by* Mr. John Edens, *of Teneriffe, one of the Canary iſlands.*

A little cloſe that lies in mooriſh ground,
Is by the following ſides encompaſs'd round;
A drain muſt be exactly three foot wide,
And into equal parts the cloſe divide;
The length of which I very fain would know:
But here obſerve, it muſt be order'd ſo,
That as little of the ſurface of the plain
May be broke up as poſſibly you can.
Juſt twenty chains the longeſt ſide contains,
The next when meaſur'd is juſt fifteen chains:
The leaſt ſide then in chains juſt ſix you'll ſee,
To prove your ſkill, you muſt explain to me.
The juſt content each equal part muſt be.
That is, when from the whole you've took the drain,
I'd know how much o'th' land doth then remain.

II. *Queſtion*

II. *Question* 48, *by Mr.* Maſſey.

A wealthy knight in Lincolnſhire reſides,
Whoſe fields are waſh'd by the redundant tides
Of Wytham's chryſtal ſtream: his chiefeſt care,
Pomona like, is how to bleſs the year
With fruitful products, from the teeming tree:
For none more vers'd in ruſtick cult than he.
Oblong in form, extended from his houſe,
He did a cloſure for his garden choſe,
With choſen walnut plants he ſet it round,
At once to ſhade his walks and load the ground
Succeeding ſummers with prolific heat
Manur'd the infant trees, and made them great,
That they expand their tow'ring heads in air,
And ſtore of barricaded kernels bear:
September laſt the knight employ'd his man
To get the nuts, and bring the kernels in.
The man returns, and with myſterious phraſe,
Premeditated, to his maſter ſays,
Sir, your commands I willingly obey'd,
And as I wrought, this obſervation made,
On ev'ry tree ſo many boughs are found
As there are trees in all your garden round:
Nine of theſe trees as many walnuts bear
As upon all the trees there branches are:
If that you multiply the ſum by three,
You in the product all your nuts may ſee.   (2187)
What, Sir, from this account I humbly crave,
Is that you tell how many trees you have.
The knight, unſkill'd in ſuch conceits as thoſe,
Took up the nuts, and ſmiling off he goes:
But turning ſhort again, ſays, Hark you Nat,
Send Mr. ———'s correſpondents that.

III. *Question* 49, *by Mr.* Hawney.

Come, artiſts, who to figures are inclin'd,
And try your ſkill four numbers for to find:
Which in progreſſion arithmetic are;
Whoſe common difference four does declare.
If theſe four numbers you ſhall multiply
Into one another continually,
The product thence ariſing you will ſee
The ſame as in the margin placed be.   (176985)
Pray then don't fail in anſwering my requeſt,
For till they out are found, I cannot reſt.

IV. *Question* 50, *by* Philomathes.

That noble lady, ſtil'd the queen of hearts,
To the ingenious a query ſtarts,
Her ſtandiſh weigh'd on earth two pounds in troy,
But on the caſtle's top, juſt ſeven miles high,
She found its weight did there not prove the ſame:
Now ſhe would know what was its loſs or gain.

V. *Question* 51, *by* Tho. Fletcher.

Show me how to find out ſuch numbers three,
That when ſubtracted ev'ry one ſhall be,
From the cube of their ſum, there may remain
Three cubes: for I ſhall ne'er this problem gain.

VI. *Question* 52, *by* Mr. Tho. Pointin.

In ancient times, 'twas in the days of yore,
When malt was taxed, there was none before:
A malſter met a gauger on the way,
And in their conference he thus did ſay:
I have a ciſtern that's exactly ſquare;
The length, breadth, and depth, all three equal are.
Another too I have o'th' ſame quality,
But leſs in each part inches forty-three:
What both will hold, you in the margin ſee. (119˙998 *buſh.*)
What hold they each? and their dimenſions?
Tell by your ſkill, and your inventions;
Or put in ladies' diary your intentions.

The Prize *Question.*

⌐ By Galilæo's heaven's high-climbing ſcale
Four * moons we ſee, to travel by and fail
This earthly globe about. Now I would know
How th' optic tube theſe jovial moons does ſhow.
Which viſible: how † ſituate they'll appear,
‡ The ſeventh of october at ten this year.

* Jupiter's ſatellites. † In reſpect to the eaſt or weſt ſide of ♃.
‡ Anno. 1716, oct. 7 day, 10 h. P. M.

1717.

Answers to the Paradoxes proposed last year.

TO *par.* 1. Anna Philomathes *says*, Any where in the torrid zone where the lat. is less than the declination of the sun, and both towards the same pole, the sun comes twice to the same point of compass both forenoon and afternoon, and an equinoctial sun-dial placed horizontally, the shadow of the gnomon shall go back, plus minus, twice every day. But because the par. mentions a certain kind of dial, I suppose, it may be thus answer'd, by a plain equinoctial dial described on both sides of an horizontal plain with two gnomons, and near the tropic when the lat. and declin. are equal, before the sun comes to the mathematical horizon in the morning he will shine on the lower side of the plain, and the shadow of the gnomon will run westward, *ad infinitum*, and presently after 6 o'clock as he shines on the upper plain the shadow runs eastward till noon, and thence to 6 even. at which time the shadow on the lower plain will begin and run westward till sun-set. There may by concave and convex, and reflex dials, be other ways of solving this.

Par. 2. The two places are not meant on the superficies of the earth, as you may perceive by the word [of] (and not upon) so the places will be so near the center of the earth, as 2 lines supposed to come, one from (o) lat. the other from 60 lat. and to meet in the center, may approach within the distance of 60 Italian miles. *A. Philom. J. Pearce, J. Wylde,* and *Ri. Hall,* answer'd this.

Par. 3. Under the north pole, the sun and full moon both decreasing in south declination and lat. will rise in the equinoctial points at the same moment, and under the north pole there is no other point of compass than south. Answered by *A. Philom. R. Hall.*

Par. 4. Anna Philomathes *answers thus,* If a person be born on 25 feb. and travel westwards the globe about, he may see 12 bissextile years before he be compleatly 44 years of age, if he be born in a bissextile year. Mr. *Moyle, R. Hall, Ob. Flower,* and *J. Pearce,* answered this paradox.

Solutions to the last year's questions.

I. *The 47th question answer'd.*

AB is 6 chains ⎫
CA 15 chains ⎬ per quest.
CB 20 chains ⎭
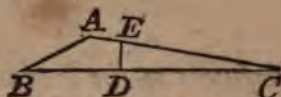
The content is easily found to be 2 acres, 3 roods, 17 perch. and 45280 parts of a perch. The drain will cut off an isosceles triangle, whose two legs will be equal, represented by EC, CD. By the doctrine of fluxions, these two theorems for finding CD and DE will come out,

$$CD = \sqrt{\frac{ab}{2}} = 269\text{'}4435 \text{ yards, and}$$

$$DE = \sqrt{\frac{2ab + c^2 - a^2 - b^2}{2}} = 51\text{'}59457 \text{ yards.}$$

Now 13837'97 yards the whole area — 51'59457 = 13786 '37543 square yards after the drain is made.*

The

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* I. QUESTION 47 *solved.*

By theorem 7 of *Simpson* on *The Maxima and Minima of Geometrical Quantities*, the required drain DE will cut off an isosceles triangle DCE; and since it must cut off half the whole (or the middle of the drain, represented by DE, is supposed to cut off half the whole), and triangles which have one angle common being as the rectangles of their sides about the common angle, we shall have as

$$2 : 1 :: AC \times CB = 15 \times 20 : \frac{AC \times CB}{2} = 150 = EC \times CD$$

$= EC^2$; and hence $EC = CD = \sqrt{150} = 12\text{'}2474487$ chains.

Now, by cor. 1 page 65 Mensuration, the triangle ABC is equal

$$\tfrac{1}{4}\sqrt{\overline{BC + CA}|^2 - AB^2 \times \overline{AB^2 - \overline{BC - CA}|^2}} =$$

$\tfrac{1}{4}\sqrt{35^2 - 6^2 \times 6^2 - 5^2} = \tfrac{1}{4}\sqrt{41 \times 39 \times 11} = 28\text{'}590875$ square chains $= 13837\text{'}9835$ square yards.

And, by the same, the triangle DCE is $=$

$$\tfrac{1}{4}\sqrt{\overline{DC + CE}|^2 - DE^2 \times DE^2} = \tfrac{1}{4}\sqrt{4CD^2 - DE^2 \times DE^2}$$

$=$ (by writing $2AC \times CB$ for its equal $4CD^2$)

$$\tfrac{1}{4}\sqrt{2AC \times CB - DE^2 \times DE^2}.$$

But, by the question, this latter triangle is equal to half the former; wherefore

$$DE^2 \times$$

II. *The 48th question anfwered by Mr.* Dod.

The lovely landfkip, owing to the art
Of modern cult, improv'd in ev'ry part,
I view'd, and with unfpeakable delight
Beheld the vernal walks; charm'd with the fight
Of feven and twenty walnut trees around,
Fertile, affording fhade to th' walking ground,
And nuts, delicious fruit! might I afpire,
And once my wifh obtain, I fhould defire
My habitation near the pleafing fcene
That calms our ruffled thoughts, and makes us all ferene.
                                    A. Naughley,

$$DE^2 \times \overline{2AC \times CB - DE^2} =$$
$$\frac{AB^2 - \overline{BC - CA}|^2}{2} \times \frac{\overline{BC + CA}|^2 - AB^2}{2}.$$

But $\dfrac{\overline{BC + CA}|^2 - AB^2}{2} = 2AC \times CB - \dfrac{AB^2 - \overline{BC - AC}|^2}{2}$;

which being written for it in the laft equation above, we have

$$DE^2 \times \overline{2AC \times CB - DE^2} =$$
$$\frac{AB^2 - \overline{BC - CA}|^2}{2} \times \overline{2AC \times CB - \frac{AB^2 - \overline{BC - AC}|^2}{2}}.$$

From this equation it is evident that

$$DE^2 \text{ is } = \frac{AB^2 - \overline{BC - CA}|^2}{2}, \text{ and hence, as in the orig. folution,}$$

$$DE = \sqrt{\frac{AB^2 - \overline{BC - CA}|^2}{2}} = \sqrt{\frac{6^2 - 5^2}{2}} = \sqrt{\frac{11}{2}} =$$

$\frac{1}{2}\sqrt{22} = 2\cdot34520788$ chains $= 51\cdot59457336$ yards $=$ the length of the drain, or $=$ its area fince its breadth is one yard.——(*And this is a very curious and remarkable theorem.*)

By fubtracting this from the whole area, we have 13786·389 fquare yards for the content remaining.

OTHERWISE.

The above folution fuppofes the drain to be a parallelogram, and that the middle line of it, or the line bifecting its breadth, divides the whole field into two equal parts: but, ftrictly and mathematical, that is not the cafe; for, by the queftion, the parts on each fide of the drain muft be equal, and then the faid middle line of the drain will divide the figure into unequal parts; as will thus appear.

Let

A. Naughley, in conclusion of an answer in verse, shews this algebraical solution: Let a be $=$ to number of trees, then $a\,a$ will be the number of all the branches, and $a\,a \times 3$ $= 2187$ by the question. Therefore by division and evolution,

$$a = \sqrt{\frac{2187}{3}} = 27 \text{ the number sought.}^*$$

III. *The 49th question answered by Mr.* M. Moyle.

Sir, fifteen, nineteen, twenty-three,
And twenty-seven your numbers be.

The same answered by Hesychia.

Fifteen and twenty-seven do, as it seems,
To the four numbers give the two extreams.

If the common difference be d, and the first number sought be equal to a, then $a \times \overline{a + d} \times \overline{a + 2d} \times \overline{a + 3d} =$ $a^4 + 6\,d\,a^3 + 11\,d^2\,a^2 + 6\,d^3\,a = 176985$ per quest. Now by

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Let $DEFG$ represent the ditch, and HI the middle line. Through H draw de parallel to BC and meeting DG, EF in d and e: Then will be formed the two little equal isosceles triangles dHD, eHE, which will be both constant and given, because the angle C and

the breadth of the ditch are so; and, since the parallelograms eI, HG are equal, as also the trapezium AF and triangle CDG by the question, it is evident that HI must be drawn cutting off the isosceles triangle $CHI =$ to $\frac{1}{2}$ the $\triangle ABC - 2$ the $\triangle eHE = a$ given area; to do which needs no pointing out here.

The calculation from hence would bring out the lines a little different from those above.

* II. QUESTION 48 *otherwise solved.*

There is one condition too many contained in this question, and it is accordingly omitted in the original solution above. If that condition be used; making x the number of trees, then $x^2 =$ the number of branches; hence $3\,x^2$ will denote the number of nuts, and $9 : x^2 :: x : \dfrac{x^3}{9}$ which will also denote the number of nuts; wherefore $3\,x^2 = \dfrac{x^3}{9}$, and $x = 27$.

by converging feries, the value of (a) will be found $= 15$ juft. Therefore $a + d = 19$, $a + 2d = 23$, and $a + 3d = 27$; but $15 \times 19 \times 23 \times 27 = 176985$ as required.*

IV. *The 50th queftion anfwered by Mr.* Fr. Walker.

That noble lady's ftandifh that weigh'd 2 pounds in troy, 47 grains did want when it was feven miles high.†

R. Beales. Xantippe, Chr. Mafon, and Mr. *Ronkefly*, an-fwered this philofophical queftion, 47 or 48 grains.

V. *The 51ft queftion anfwered by* Rob. Beales *and Mr.* Ber-riffe, *and no other.*

> For thofe cube numbers 3, fo nicely to be
> That when every one is fubtracted,
> From the cube of their fum, and yet to remain
> Three cubes; has me almoft diftracted.

Thus $\dfrac{494424}{2352637}$, $\dfrac{472696}{2352637}$, and $\dfrac{448000}{2352637}$: Which taken

feverally from $\dfrac{512000}{2352637}$ the cube of their fum, leaves thefe

<div align="right">3 cubes,</div>

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* III. QUESTION 49 *otherwife folved.*

Let $x + 2$ and $x - 2$ denote the two means, and $x + 6$ and $x - 6$ the two extreams; then, by the queftion, $\overline{x + 2} \times \overline{x - 2} \times \overline{x + 6} \times \overline{x - 6} = x^2 - 4 \times x^2 - 36 = x^4 - 40x^2 + 144 = 176985$; or, completing the fquare, $x^4 - 40x^2 + 400 = 177241$; the root of this is $x^2 - 20 = 421$, or $x^2 = 441$, and hence $x = 21$. Whence, the numbers are 15, 19, 23, 27.

† IV. QUESTION 50 *folved.*

Since the gravitation or weight of a body above the earth, is inverfely as the fquare of its diftance from the earth's center; if the earth's radius be fuppofed equal to 3993 miles, we fhall have

$4000^2 : 3993^2 :: 2 lb.$: the weight at 7 miles high; hence $4000^2 : 4000^2 - 3993^2 :: 2 lb.$: the diminution,

Or $4000^2 : 7993 \times 7 :: 2 lb.$: $\dfrac{7993 \times 7}{8000000} = \cdot006993875 \ lb. = 36\cdot28472$ grains $=$ the weight loft, or the decreafe of gravity at that height.

3 cubes, $\dfrac{17576}{2352637}$, $\dfrac{39304}{2352637}$, and $\dfrac{64000}{2352637}$; whose roots

are $\dfrac{26}{133}$, $\dfrac{34}{133}$, and $\dfrac{40}{133}$.*

W. Beriffe.

VI. The

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* V. QUESTION 51 *solved*.

This is question 19 *Lib.* 5 of *Diophantus*, and is one of the most difficult in his book; the numbers in answer are brought out by his commentator *Bachet*. Our countryman *Kerfey* and several others have solved this problem, and brought out other numbers answering the conditions. The various methods of solution are much the same as to the essential principles; but we shall give one nearly in substance according to *Schooten*, which seems to be as clear as any, who says he learned it by reading *van Collen*'s letters, and who thought so highly of his solution, that he subscribed it with, *Cujus rei soli Deo debetur gloria*.

By putting for the sum of the numbers required $4n$, whose cube is $64n^3$; and $63n^3$, $56n^3$, and $37n^3$, for the numbers themselves; each of which being taken from $64n^3$, there remain n^3, $8n^3$, and $17n^3$, three cube numbers as there ought. But also the sum of the numbers $156n^3$ ought to be $= 4n$; hence $39n^2 = 1$; and, to get n, the coefficient 39 ought to be a square.

To find numbers therefore, so that the said coefficient may be a square, let the sum of the numbers be 4, and two of the remaining cubes let be $\overline{n-1}|^3$, and $\overline{4-n}|^3$; each of these cubes being taken from 64 the cube of the sum, there remain $65 - 3n + 3n^2 - n^3$, and $48n - 12n^2 + n^3$ for two of the numbers; whose sum is $65 + 45n - 9n^2$; to make the first term of this a square by adding to it the third number, which must also be the difference between the cube 64 and the 3d remaining cube, it appears that the said 3d cube must be 8; for then $64 - 8 = 56 =$ the 3d number; which added to the sum of the two former numbers, we have the sum of all the three $= 121 + 45n - 9n^2$. To make this a square, suppose it $= \overline{11 + n}|^2 = 121 + 22n + n^2$; hence $n = \dfrac{23}{10}$; which

substituted in the above values of the numbers, they become $\dfrac{61803}{1000}$, $\dfrac{59087}{1000}$, and 56; or rather these are proportional to the numbers sought.

But we have not yet provided for the equality between the sum of these numbers and the assumed sum; wherefore, to include that condition, let $4z$ be the sum of the numbers, and the numbers themselves $\dfrac{61803}{1000}z^3$, $\dfrac{59087}{1000}z^3$, and $56z^3$; the sum of these is $\dfrac{17689}{1000}z^3 = 4z$; hence $\dfrac{17689}{100}z^2 = 1$, and $z = \dfrac{20}{133}$. Which substituted

* VI. *The 52d question answered by* Mr. Ed. Moore.

> I've here agreed, in time of need,
> At once to make two friends;
> If gauger's eas'd, and malster's pleas'd,
> I'll look for no amends.

The side of the biggest cistern 62·9999314825 inches.
The side of the lesser —— 19·9999314825 inches.
The biggest 116·2793 bushels. Lesser 3·7187 bushels.

A. Philomath.

Which may be found thus : Let $43 = $ difference of the sides, be $= d$, and the side of the greater $= a$, the side of the lesser shall be $= a - d$, and the sum of their cubes $= 2aaa - 3da^2 + 3d^2 a - d^3 = 119·998$ bush. $\times 2150·42$, the solid inches in a Winchester bushel $= 258046·099$ inches, and the value of a will be found $= 63$ proxime; consequently

$a - d = 20$ inches. Then $\dfrac{63.3}{2150·42} = 116·278$ bush. and $\dfrac{20^3}{2150·42}$

$= 3·720$ bushels, but their sum $= 119·998$ required.

A. Naughley, *W.* Whitworth, *T.* Cooch, *R.* Phillips, Xantippe, *Ja.* Wylde, *John Smith* of Hoppesford in Warwickshire, *J.* Canning, *W.* Beriffe, *J.* Pearce, *J.* Symmonds, *C.* Mason, *J.* Stocks, *W.* Jachling, *T.* Court, *W.* Rankesley, and *W.* Crabb, answered this question.

The

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substituted for it in the above assumed values of the numbers, we have $\dfrac{494424}{2352637}$, $\dfrac{472696}{2352637}$, and $\dfrac{448000}{2352637}$ for the 3 numb. required.

And these answer all the conditions ; for their sum is $\dfrac{1415120}{2352637} = \dfrac{8}{133} = 4z$; and the cube of this sum diminished by the three numbers themselves leave $\dfrac{17576}{2352637}$, $\dfrac{39304}{2352637}$, and $\dfrac{64000}{2352637}$; which are three cube numbers, whose roots are respectively $\dfrac{26}{133}$, $\dfrac{34}{133}$, and $\dfrac{40}{133}$.

* VI. QUESTION 52 *solved.*

This question may be otherwise more simply solved thus : Let z denote the half sum of the sides of the cubes, and $d = 21\frac{1}{2}$ the half difference ; then will the sides themselves be $z + d$ and $z - d$; and the sum of their cubes is $2z^3 + 6d^2 z = 119·998 \times 2150·42$ (the inches in a bushel), or $z^3 + 1386\frac{1}{4}z = 59·999 \times 2150·42$. Hence $z = 41\frac{1}{2}$ nearly ; and consequently the sides $= 63$ and 20.

The Prize Question answered by Mr. T. Wright, *A. B. of Hart-Hall, Oxon. and who won the prize of* 10 *diaries.*

> I'll tell exact how Jove's four moons appear,
> On october the seventh, at ten this year.   1716.
>   As for the first but little can be said,
> For he's at midnight rest within the shade.
> The third, will from his master nigh be run
> Its greatest distance towards the setting sun.
> Likewise the second, will on the same side be, ⎫
> Toward the third, from Jove two parts in three, ⎬
> The fourth is nearest, in the east you'll fee.* ⎭

To this difficult question I received but another true answer, viz. by Mr. *Ronkesley*, of Hodroyd, by Wakefield, in Com. ⌐borac. This part of astronomy is what but very few have the happiness of seeing; it requiring a telescope of a consⁱ⌐⌐rable length to reach the satellites of Jupiter.

Mr. Ronkesley's *answer.*

> The first immerg'd, on's east the fourth you'll see,
> The third and second, on the west will be.

An

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* PRIZE QUESTION *answered.*

It is evident that the difference between the geocentric place of Jupiter and the place of each of his satellites, for the given time, will give their distances from him in signs, degrees, &c. which may be turned into semidiameters of Jupiter. To do all which is fully taught in most books of astronomical tables. These calculations made for the proposed time will give the distances in semidiameters and tenths of Jupiter thus; viz. 1st satellite $=$ 0.8 W. the 2d sat. $=$ 7.9 W. the 3d sat. $=$ 15.0 W. and the 4th sat. $=$ 2.2 E. Which being drawn from a scale of equal parts will appear thus
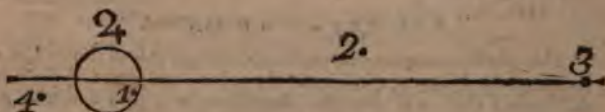
Where the configurations are adapted to the explanation given in the Nautical Almanac.

An account of Eclipses to be published.

In this place I defign'd to have given an account of fome
more of the vifible eclipfes of the fun, as I did in my laft,
having them already calculated; but finding mine to agree
fo near to Dr. *Halley*'s, both of that great one paft 22d april,
1715, and that yet to come in 1724, whofe calculations I
take to be grounded on the beft hypothefis yet difcover'd,
improved by the moft accurate obfervations. I defign to
publifh in a fheet, engraved and printed, all the vifible e-
clipfes of the fun that will happen before the year 1763, with
their beginnings, middle, and endings, with exact types fhew-
ing the parts and digits eclipfed, their durations, and moon's
latitude at the beginning, middle, and end of each, exactly
calculated by *Aſtronomia Carolina,* for the meridian of Co-
ventry, near the middle of England: of which timely notice
will be given in the public papers. And here I am glad of
an opportunity of doing juftice to my induftrious and indefa-
tigable countryman Mr. *John Chattock,* late of Caftle Brom-
wich, in Warwickfhire, by letting the world know I have all
along compared mine with his calculations (done from *Wing*'s
Scientiæ Stellarum) in manufcript now in my hands, whofe
ability in thefe fciences, the two excellent almanacs he pub-
lifhed in 1708 and 1710 manifeft. Whoever confiders the
care and pains that attend fuch calculations, will readily
excufe fome fmall errors that poffibly may efcape; fuch fhall
on notice be corrected in the enfuing diaries.

Here follow fome obfervation of the moon's eclipfe paft
october 1715, and fome of the immerfions and emerfions of
Jupiter's fatellites, whofe ufes in finding longitude have long
been approved, and others made of this kind will be grate-
fully received by the author from fuch as are fo much friends
to this noble fcience as to communicate them.

The moon's eclipfe 31ft october, 1715, in the morning, I
obferved at Newnham, in Warwickfhire, lat. 52° 32′, long.
5 minutes in time after London, by a large quadrant and
rectified pendulum; at the middle of this eclipfe a line drawn
by the two extremities of the horns of the enlightened part
of the moon, made an angle with the horizon towards the
fouth of 54 degrees, in which line 5 degrees diftant above
was Jupiter, and perpendicular over the moon 11 degrees
diftant the Pleiades, her altitude being then 27° 26′ the hour
4 h. 15 m. at 4 h. 45 m. 6 digits eclipfed; and moon's horns
perpendicular at 5 h. 2 m. and dig. 3½; 15 minutes before
the end the 2 horns made a north angle with the horizon of
84°: the eclipfe ended in the moon's limb diametrically op-
polite

pofite to the river Palus Mæotis, at the altitude of 16° 30',
and the hour 5 and 34 minutes.

At Crew, in Chefhire, it was obferved, as well as the
foggy air would permit, as follows.

			Crew		Newnh.	
			h.	m.	h.	m.
The beginning or penumbra	—	—	2	36	2	50
Ætna immerged at — —	—	3	1¼			
Befbieus immerged at — —	—	3	15½			
North part of Mæotis immerged — —	3	33½				
South part of Mæotis immerged — —	3	41				
The middle about 8 digits eclipfed	—				4	15
Palus Mæotis emerged at — —	4	30				
The end at — — — —	5	24⅝			5	34
The whole duration — — —	2	48½			2	44

By the fame perfon, and at the fame place, was the emer-
fions and immerfions of Jupiter's fatellites obferved, as oft as
the air would permit that feafon.

1715.	d.	h.	m.	s.		2 Sat. emer. dec.	d.	h.	m.	s.
♃ 1 Sat. im. fep.	26	8	59	15		2 Sat. emer. dec.	29	5	4	10
2 Sat. im. oct.	8	8	55	30		1 Em. dec.	29	6	8	50
3 Sat. em. nov.	28	16	1	20		2 Sat. em. mar.	9	7	33	19
3 Sat. em. dec.	27	7	52	45		1 Sat. em. mar.	14	8	51	55

Apparent time.

By feveral obfervations, the times precede thofe of the
calculations by the tables, by about 7 or 8 minutes. The
regularity of which errors proves the obfervations the more
accurate.

This year laft paft has produced feveral uncommon ap-
pearances in the air, as that unaccountable phænomenon
on the 6th March, 1716, the halo's oft' feen, and heavenly
bodies vifible at noon, and according to this verfe drew
men's eyes upwards.

> Os homini fublime dedit : cælumque tueri
> Juffit, & erectos ad fidera tollere vultus.   *Ovid.*

The eclipfes of this year 1717.

There will happen in this year, 1717, four eclipfes, two
of each luminary : The firft is one of the moon, on the 16th
day of march, when the earth will interpofe between the fun
and moon, and hinder the fun's enlightning her, on her up-
per (or north) part above one half of her diameter appear-
ing dark. The calculation I have deduced from the Caroline
tables.

The

		h.	m.	s.
The mean oppofition march 15th day, 1717 —		20	50	29
Interval of the mean and middle ☍ fubtract —		6	4	43
The middle or equal time of the oppofition —		14	45	46
At which time the fun's place is in Aries — d.	6	17	55	
And the moon in Libra — — —		6	16	47
Difference from the oppofition want — —			1	8
Hourly motion of ☉ 2′ 28″, of ☽ 33″ 14″ differ.			30	46
As 30′ 46″ to diff. 1′ 8″ :: 60 to the interval add			2	13
The middle time of the true ☍ 15° day —		14	47	58
At which time ☉ is in ♈ — — fig. 0	6	18	55	
And the moon in Libra — — — fig. 6	6	18	46	
The ☋ fubtract by ☽'s place — — fig. 6	13	43	1	
Remains the argument of latitude — —		7	24	15
☽'s lat. 39′ 6″ nor. afcending reduction fubt. —			1	41
Hourly motion of ☽ 33′ 55″, of ☉ 2′ 28″ diff.			31	27
As 31′ 27″ to red. 1′ 41″ :: 60′ to the ti. of rif. fub.			3	12
The equal time of the true ecliptic ☍ — —		14	44	47
Equation of time add — — —			10	
The apparent time of the true ☍ at London		14	54	47
The ☉'s horizontal parallax 15″, ☽'s 56′ 56″ fum			57	11
Subtract 15′ 56″ femid. ☉ rems femid. ☉'s fhad.			41	15
To which add femid. ☽ 15′ 24″ the fum is —			56	39
Latitude of the ☽ fubtract — — —			39	6
Remains the parts deficient — — —			17	33
As 15′ 24″ to 6 digits :: 17′ 33″ to the digits ecl.		6	50	0
Reduct. or interval of greateft obfcuration add			6	22
To the appar. times gives the greateft obfcur. at		15	1	9
As 31′ 27″ to 60′ :: min. of incidence 41′ to } half duration* — — — — }		1	18	13

Hence

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* This eclipfe of march 15th, was obferved as follows.

Places	Obfervers	Beginn.	End	Digits eclip.
		h. m. s.	h. m. s.	
Lima in Peru	D. Peter Peralta	8 4 8	11 19 55	
Cambridge, New England	Mr. Robie	9 about	11 42 30	
The Ifland of Virgin Gorda	Capt. Chandler		12 30 0	
St Cofma in South America	F. Bon. Suarez	10 2 21	12 45 40	7$\frac{3}{10}$
Paris — — —	Mr. Caffini	13 55 0	16 38 25	7$\frac{1}{2}$
Paris — — —	Mr. de la Hire	13 54 0	16 38 10	7$\frac{1}{3}$

Hence the eclipse march, 16°, 1717.
The beginning 42 min. 48 seconds past I. in the morning.
The middle 1 min. past III. in the morning.
The end 19 min. 14 seconds after IV. in the morning.

A type of the moon's eclipse the 16th of march, at 3 in the morning.

	m.	s.
Semidia. of shad. ER	41	15
Initial lat. of ☽ eG	41	37
Medial — EM	39	6
Final lat. ☽ — eI	33	59
Semidiam. of ☽ RB	15	24

G the ☽ at begin. M at midd.
I at end, eEe the ecliptic.
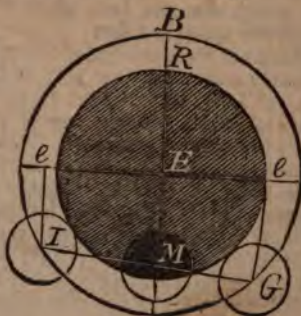
The second is of the sun, 31st of march, at 19 minutes past 4 in the evening; but although the moon be but 70° 46' from the south node, and near 4° within the eclipsing bounds, yet her lat. being then 4°' south, and the sun's declination about 8° 2' north, hinders the moon's shade falling near us, and therefore called invisible to any of the northern parts.

The third is of the moon on monday the 9° of september, at 6 in the evening, when 7 digits 26 minutes of the moon's diameter will be darkened on her lower or south part of her disk. So much as room will permit of the calculation follows.

Sept. 9°, 1717. Eve. h. m. s.

The corr. eclip.	8	6	13	20
Appar. time Lond.	6		4	40
Beginning aftern.	IV	46	58	
Mid. vel max. obf.	VI	11	3	
End — —	VII	35	8	
Whole duration	II	48	10	
Digits eclipsed		7	26	40
Moon's lat. at beg. EB	40	25		
At end, alfo ⎰ EE	32	29		
nor. def. ⎱				
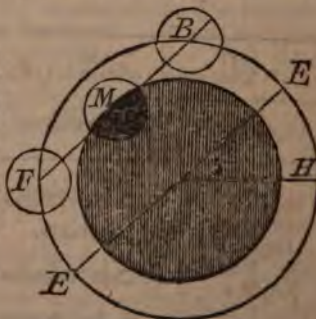
This figure shews exactly the appearance of this eclipse; *B* shews the moon where it begins, *M* at the middle, and *E*

at

at the end, *E E* is the ecliptic, *E M B* the moon's way, and *F H* is the horizontal line in the eclipse.*

The fourth is an eclipse of the sun on monday the 23d of september, at 9 minutes past 7 in the evening; but the moon's lat. being 1° 17' north, and the sun's decl. 4° 40' south, the shade would not fall near us, tho' the sun was not set.

Paradoxes · to be answer'd next year.

1. There's a certain village in the south of Great Britain, to whose inhabitants the body of the sun is less visible about the winter solstice, than to those who reside upon the island of Iceland.

2. There's a certain place of the earth, of a considerable northern latitude, where, tho' the days and nights (even when shortest) do consist of several hours; yet in that place it is mid-day or noon every quarter of an hour.

3. There are divers places on the globe of the earth, where the sun and moon, yea, and all the planets, do actually rise and set according to their various motions; but never any of the fixed stars.

4. There is a certain city in the southern part of China, whose inhabitants (both male and female) do observe almost the same posture and gait in walking as we Europeans; and yet they frequently appear to strangers, as if they walked on their heads.

Twenty-four of those amazing paradoxes in *Gordon's Geography* have been inserted in the ladies' diary; twenty of which are in it already, explain'd; so in time the whole forty-five will be solv'd.

A.

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* The eclipse of Sept. 9 *P. M.* was observed thus,

Places	Observers	End
London —	Royal Society —	7h. 27m.
Paris — —	M. Cassini — —	7 34 50s.
Paris — —	M. de la Hire —	7 34 15
Paris — —	M. Miraldi —	7 35 30
Norimburg	M. Wurtzelbaur	8 10 45

On monday June 10th this year, Dr. Halley discovered a small telescopical Comet; whose place at 11 o'clock that evening was ♐ 17° 12' with 4° 12' south latitude.

A Philosophical Question, by A. Philomathes.

A golden ball shall weigh two pounds in troy,
Where from th' equator ten degrees does lie;
But at London, a diff'rent weight is found
Of that same ball: which diff'rence pray expound.

New Questions.

I. *Question 53*, by *Mr.* Tho. Dod.

A fortunate merchant got riches good store,
And had jewels so many, you'd ne'er desire more:
But the way to secure them, he cover'd them over
With cloth for his buttons, so none cou'd discover
The worth of his coat, he had on his back;
Which above a pistole you'd ha' sworn ne'er wou'd take:
So by this means he carry'd it safe; and 'twas sold
After such an odd way as you never heard told.
Some jewellers then that were ready to doat
On the buttons, did join for to buy the rich coat;
And agreed in proportion geometrical
Thus to pay for the coat by the buttons, which all
Were no more than sixteen; and a penny was paid
For the first button only: the last, as they said,
To this number of pence*, sir, you see, did amount:
So they ask'd me to try with my pen, and to count
What the sum was in pounds, shillings, pence, which it cost;
But by trying, I found myself presently lost:
For I wanted to know how the ratio increas'd;
Which, if you will shew, I'll be very much pleas'd:
Or, I'll thank you to tell me but what the coat cost,
In a line to your servant, sir, by the next post.

* 14348907 pence.

II. *Question 54*, by *Mr.* Rob. Beales, *of Lynn*.

If London from Norwich be miles ninety-nine,
And from those two cities two footmen design,
The first to go three miles the first day from London,
The second day five miles; next sev'n, and so on
Towards Norwich, from whence the second one must
The same time go for London to meet with the first;
Whose first day's journey exactly is fix'd
To be of the days they'll meet on, the sixth:
His second day's journey does also agree
To exceed the first in miles just by three,
So each day's journey in excess must be.

From

From this I would know, how you'll difcover
The days they'll be going till they meet one another:
And how many miles then each will have gone,
Is what I requeft you'll be pleas'd to get done.

III. *Queftion* 55, *by* Xantippe, *of Helmfley, Yorkfhire.*

Once, as I walk'd upon the banks of Rye,
To fee the purling ftreams glide gently by,
And hear the pretty birds to chirp and fing,
Making the groves with melody to ring;
I in the meads three beauteous nymphs did fpy,
Who there for pleafure came as well as I;
And unto me their fteps they did direct;
Saluting me with moft benign refpect:
Saying, ' Well met: we've bus'nefs to impart,
' Which we cannot decide without your art.
' Our grannum's dead, and left a legacy,
' Which is to be divided 'mongft us three.
' In pounds it is two hundred twenty-nine,
' And a good mark, it being fterling coin.'
Then fpake the eldeft of the lovely three,
' I'll tell you how it muft divided be;
' Likewife our names I unto you will tell;
' Me they call Moll, my fifters Anne and Nell:
' As oft as I five, and five-ninths do take,
' Four and three-fev'nths Anne takes, her part to make;
' As oft as Anne four and one-ninth does tell,
' Three and two-thirds muft be took up by Nell.

IV. *Queftion* 56, *by Mr.* W. Beriffe, *of St. Ives.*

Ingenious algebraift, I fain wou'd know
An anfwer to this queftion here below.
　A friend of mine afk'd me the other day,
A little fpot of land for to furvey,
That lay in form of a tripezia.
I foon comply'd with his requeft, and found
Three acres, wanting fixteen poles, of ground;
The fides in chains here you may plainly fee;
The firft was four, the fecond juft twice three;
Seven was the third; and for the fourth thus reckon'd,
It being juft the half of firft and fecond.
No parallel fides to you I muft declare,
Nor angle right will be admitted here.
Ye fons of art, I do requeft you all
To give a cannon algebraical,
To find the length of the diagonal.

But

But one word more, left you be overfeen;
It is the longeft which I here do mean.

V. *Queftion* 57, *by* J. Symmons.

  Dick Dibble is almoft out of his fenfes,
And begs me to be his amanuenfis
To th' ladies, that in their next diary
They'll pleafe to anfwer a gard'ner's query:
For orders lately from his mafter came,
That puzzle poor Dibble: altho' the fame
To many others wou'd plain enough fpeak:
Dick fays, the moft on't is mere heathen greek.
A workman from him fome directions muft take,
About fome dials that he is to make:
But he or the t'other can nothing effect,
Except the fair ladies, in pity, direct.
His mafter's firft words to Dibble confound;
Degrees fifty-two, fifty minutes is found
The latitude, in the midft of the ground.
There on the plane a ftreight ftaff you muft fix
At right angles; on whofe top, or apex,
Fourfcore inches high, a fmall knob or ball.
March the fecond, mark how the fhadow doth fall
From the foot of the ftaff, juft on a fouth fun.
The 11th of june the fame muft be done,
When the fun is due weft. Thefe lengths being got,
Are half the diameters of the grafs plot:
Which is an ellipfis or oval to be,
The area, in inches, divide into three;
Two-thirds of that fum the mafon muft take,
For a ftone ftep that he is to make
Of elliptical form, and five inches deep:
Whofe length and breadth equidiftant muft keep
From the verge o'th' other great one of grafs;
On the ftep four lions couchant of brafs,
Supporting a cube: which ferves as a bafe
To a dodecaedron; and that bears a fphere.
Thefe folid bodies this proportion muft bear
Of fix, three, and one, exactly (or near)
The area's third, thefe bodies muft have.
Now ladies, Richard moft humbly does crave,
What the fides of the cube and dodecaedron are?
And what is the axis alfo of the fphere?

VI. *Queſtion* 58, *by the Lady* Mer. Heyſhot.

Two ſons I have, comfort to me impart,
And when in view, they do rejoïce my heart.
How old they be, is all I fain would know,
Suppoſing true what here I ſtate below.
The age of one being ſquar'd, if from 't you take
The younger's age, the réſidue will make
As this (425): then ſquare the younger's age,
From which deduct the elder's, and I'll engage,
The reſidue two hundred thirty-five you'll find.
Their age to tell, pray ladies, be ſo kind.
This I forgot: if to fifteen ſquar'd you add
A hundred, their ages' product may be had.

The Prize Queſtion, of 10 *diaries to the anſwerer.*

Upon a horizontal plane there ſtood
A handſome tetrahedron, very good;
I lik'd it well, and well the ſame I view'd,
And found five ſolid feet its craſſitude:
Beſide it ſtood a priſm triangular,
Whoſe height and ſide at baſe both equal are;
Its content thirty-ſix ale gallons good,
But being bottomleſs, while ſo it ſtood,
To put in liquor none there venture wou'd.
At laſt I fix'd the priſma very tight
Upon the tetrahedron that was by't;
This done, ſaid I, ſee by this piece of ſkill,
With ale or beer, the veſſel ye may fill.
I aſk the gaugers now, how much they think
There's in the caſk, of ale or other drink?
In anſwer to the query, pray unfold,
How much at once the caſk ſo plac'd can hold:
And alſo tell, how much th' elevation
O'th' priſma is above its former ſtation:
But to prevent miſtakes i'th' gauging part,
Know, that a pyramid well wrought by art
Triangular, the mouth cloſe down did ſtop,
Whoſe point juſt touch'd the tetrahedron's top.
I've ſaid enough, by which the artiſts know
The anſwer of the query how to ſhow.

1718.

Answers to the Paradoxes proposed last year.

Par. 1. MR. *R. Budgen* says the village lies under a high mountain near Lewis, in Suffex; that about the winter solstice the sun is but a very small space of time visible to the inhabitants.

Par. 2. Under the north pole.

Par. 3. Under the poles the planets by their motions get north or fouth declination, confequently rise and set with relation to those two places: but the fix'd stars keeping an exact distance from the pole, may be said *never* to rise, or fet, tho' their motion on the poles of the ecliptic may be thought fome fmall objection to this paradox.

Par. 4. In China, (or any other place) where the inhabitants stand near the fea, strangers looking in it must fee them, as tho' their heads were downward by the reflected vision.

An answer to the philosophical question.

Mr. *John Wilkinson* fays, the proportion of gravity betwixt the equator and poles, is as 500 to 501, by the incomparable Sir *Isaac Newton*; and the increase near as the fquare of the right fine of the latitude; and that the ball would weigh more at London than at 10 deg. lat. by 13 grains.

This is, I prefume, occafioned from the earth's oblate figure, and the diminution of the centifrugal force.

Mr. *Doidge*, Mr. *White*, Mr. *Bleathman*, Mr. *E. Weaver*, and Mr. *R. Hall*, anfwer'd the 2d and 3d paradoxes. Mr. *Whitworth* 2d, 3d, and 4th, Mr. *Langley* 2d, Mr. *Mason* 3d, Mr. *Budgen* 1st and 3d, Mr. *Child* 2d and 4th.

Solutions to the laſt year's queſtions.

I. *Queſtion 53 anſwered by Mr.* J. Peirce.

$\sqrt[15]{14348907} = 3$ the ratio. Let p be = firſt term = 1, s = ſecond term = 3, u = laſt = 14348907, and z = ſum of all the terms. Now $z - u$ = ſum of all the antecedents; $z - p$ = ſum of all the conſequents. Therefore $p : s ::$ $z - u : z - p$; and by equality $pz - pp = sz - su$ by tranſpoſition, and diviſion, $z = \frac{3\,u - 1}{2} = 21523360$ pence = 89680 *l.* 13 *s.* 4 *d.*

* II. *Queſtion* 54 *anſwered by* R. Hall.

Their journey went to ſix days,
  Before they met each other;
The Londoner he went ſo faſt,
  Three miles out-ſtrid the other.   51 and 48.

III. *Queſtion*

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* II. QUESTION 54 *ſolved.*

Putting x for the number of days they travelled, or the number of terms in each ſeries, of which the two common differences are 2 and three; the correſponding firſt terms will be 3 and $\frac{1}{3}x$, the laſt terms = $\begin{cases} 2 \cdot \overline{x-1} + 3 = 2x + 1 \\ 3 \cdot \overline{x-1} + \frac{1}{3}x = 3\frac{1}{3}x - 3, \end{cases}$

the ſums of each pair of extremes = $\begin{cases} 2x + 4 \\ 3\frac{1}{3}x - 3, \end{cases}$

and the ſum of each ſeries, or the miles each travelled = $\begin{cases} x^2 + 2x \\ \frac{1}{3}x^2 - \frac{1}{2}x. \end{cases}$

Then by taking the ſum of theſe two ſums, we have $\frac{4}{3}x^2 + \frac{3}{2}x = 99$; and hence $x = 6$ = the number of days, and $\begin{cases} x^2 + 2x = 48 \\ \frac{5}{3}x^2 - \frac{1}{2}x = 51 \end{cases}$ = the miles each travelled.

* III. *Queſtion 55 anſwered by Mr.* J. Simmons

$91 l.$ $11 s.$ $4 d.$ $\frac{1622}{2842}$ Is the ſhare for Molly,
72 19 10 $\frac{1121}{2842}$ Is what Nan ought to take,
65 2 0 $\frac{2011}{2842}$ Makes the part for Nelly,
—————————
229 13 4 If I've made no miſtake.

IV. *Queſtion 56 anſwered by Mr.* Ja. Peirce.

Let $BC = 4 = b,$ $AD = 7 = g,$
    $CD = 6 = c,$ $AB = 5 = f,$
$CD + BC = 10 = e,$ $AD + AB =$
             $12 = h,$
$CD - BC = 2 = d,$ $AD - AB =$
             $2 = i.$

The area 2 a. 3 r. 24 per. = 29 ſq. cha.
= a. *Quere* diagonal $BD = y.$

(1). $y : e :: d : \dfrac{de}{y} = DE - EB;$

and $y : h :: i : \dfrac{hi}{y} = DF - FB.$

(2). $\dfrac{yy + de}{2y} = DE,$ and $\dfrac{yy + hi}{2y} = DF.$

                                        (3).

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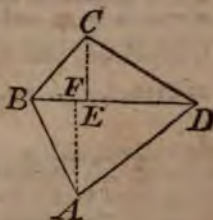
* III. QUESTION 55 *ſolved.*

The numbers $5\frac{5}{9}$ and $4\frac{3}{7}$, or $\dfrac{50}{9}$ and $\dfrac{31}{7}$ are in proportion as

350 and 279; and the numbers $4\frac{1}{9}$ and $3\frac{2}{3}$, or $\dfrac{37}{9}$ and $\dfrac{11}{3}$ are to

each other as 37 to 33. Now, $279 : 350 :: 37 : \dfrac{37 \times 350}{279}$;

and hence the three ſhares muſt be in proportion as the three num-

bers $\dfrac{37 \times 350}{279}$, 37, and 33; or as 37×350, 37×279, and

33×279; that is, as the numbers 12950, 10323, and 9207;
whoſe ſum is 32480.

Whence, by proportion, we ſhall have as $32480 : 229 l. 13 s. 4 d.$
$$\begin{cases} 12950 : 91 l. 11 s. 4\frac{324}{406} d. = \text{Moll's ſhare,} \\ :: 10323 : 72 \quad 19 \quad 10\frac{212}{406} = \text{Ann's ſhare,} \\ 9207 : 65 \quad 2 \quad 0\frac{270}{406} = \text{Nell's ſhare.} \end{cases}$$

(3). $\sqrt{\dfrac{4c^2y^2 - y^4 - 2dey^2 - d^2e^2}{4y^2}} = CE$:

$\sqrt{\dfrac{4g^2y^2 - y^4 - 2biy^2 - b^2i^2}{4y^2}} = AF$.

(4). Thefe two laſt × by ½y, and added together give the area.

(5). Then by extracting the fquare root of the denom. and multiplying a by 4, you'll have

$$\sqrt{4c^2y^2 - y^4 - 2dcy^2 - d^2c^2} +$$
$$\sqrt{4g^4y^2 - y^4 - 2biy^2 - b^2i^2} = 4a.$$

(6). By fquaring both ſides of the laſt equation, and tranf-ferring the rational terms to one ſide, you'll have (after making $4c^2 - 2cd = k$, $- ddee = -l$; $4g^2 - 2bi = m$, $- bbii = -n$;) $2\sqrt{ky^2 - y^4 - l} \times \overline{my^2 - y^4 - n} = 16aa - ky^2 - my^2 + 2y^4 + l + n$.

Let $16a^2 + l + n = p$, and $- ky^2 - my^2 = - qy^2$.

(7). By fquaring both ſides of this laſt (p and $-q$ rightly placed) you'll have $4kmy^4 + 4ly^4 + 4ny^4 - 4lmy^2 - 4kny^2 - 4my^6 - 4ky^6 + 4y^8 + 4ln = p^2 + 4py^2 + q^2y^4 - 2pqy^2 + 4y^8 - 4qy^6$.

(8). But $4y^8 = 4y^8$ is deſtroyed; alſo by ſuppoſition $m + k = q$. Therefore $- 4my^6 - 4ky^6 = - 4qy^6$, which will be deſtroyed. Laſtly, by tranſpoſing the known quantities to one ſide, and the unknown to the other, you'll have $4kmy^4 + 4ly^4 + 4ny^4 - 4py^4 - q^2y^4 + 2pqy^2 - 4lmy^2 - 4kny^2 = p^2 - 4ln$.

Let $4km + 4l + 4n - 4p - qq = r$; $2pq - 4lm - 4kn = s$, and $p^2 - 4ln = t$. Then $ry^4 + sy^2 = t$.

From whence will ariſe this theorem,

$$y = \sqrt{\sqrt{\dfrac{ss}{4rr} + \dfrac{t}{r}} - \dfrac{s}{2r}} = 7\cdot682 \text{ chains, the longer}$$

diagonal; the other is $7\cdot554$ chains.*

V. *Queſtion*

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* IV. Queſtion 56.

Conſtructions and other ſolutions of this queſtion may be ſeen in *Simpſon's* Algebra and his Select Exerciſes.

* V. *Queſtion* 57 *anſwered by* Ja. Peirce, Wm. Whitworth, Joſ. Wilkinſon, *and* Moſes Bleathman.

Mar. 2. Sun's longitude 22° 56′ 34″ ♓. Declin. 2° 48′ 28″ S. The ſun's meridian altitude, 34° 21′ 32″.

Length of the ſhade, 117·056 inches ; which doubled, gives the conjugate diameter of the oval 234·112 inches.

June 11. Sun's longitude — — — ♋	0°	55′	41″
Declination north — — — —	23	29	48
Sun's altitude eaſt or weſt — — —	30	1	16
Length of the ſhadow —	138·4 inches		
Doubled the tranſverſe diameter	276·8		
The area of the oval — —	50916·0155		
$\frac{1}{3}$ Taken for the 3 ſolid bodies —	16972·0051		
$\frac{2}{3}$ For the ſtep — — —	33944·0102		
Tranſverſe diam. of ſtep — —	116·716		
The conjugate diam. of the ſtep	74·028		
The ſide of the cube — —	21·675		
Side of the dodecaedron — —	8·726		
Diameter of the globe — —	14·799		

VI. *Queſtion*

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* V. Q U E S T I O N 57 *ſolved.*

The method of ſolving this queſtion is thus :

By aſtronomical tables find the ſun's place or longitude to the two given times ; and the obliquity of the ecliptic or the greateſt declination for the ſame : then, by ſpherics, it will be, as radius : ſine long. :: ſine obliq. : ſine of the preſent declinations. In the firſt caſe, the declin. taken from the colat. leaves the meridian altitude ; and in the other, we ſhall have, by ſpherics, as s. lat. : s. obliq. :: radius : s. altitude. Theſe altitudes being thus computed, we ſhall ſuppoſe to be 34° 21′ 32″ and 30° 1′ 16″ as in the original ſolution above.

Then, by plain triangles, as 1 (rad.) : 80 (length of ſtaff) :: cotang. alt. : length of the ſhade ; conſequently 160 × 1·4611874 (cotang. 34° 21′ 32″) = 234·034176 inches = the conjugate diameter, and 160 × 1·7305780 (cotang. 30° 1′ 16″) = 276·89248 = the tranſverſe diameter ; and hence the area of the green is 276·89248 × 234·034176 × ·78539 &c. = 50895·58. Then $\frac{1}{3}$ of this being a number expreſſing the ſum of the contents of the three ſolids, which are in proportion to one another as 1, 3, and 6, whoſe ſum is 10 ; we ſhall have, as 10 : $\frac{50895·58}{3}$.

$$1:\{ \begin{array}{l} 1 : 1696·519 = \text{the content of the ſphere} \\ 3 : 5089·558 = \text{the content of the dodecaedron} \\ 6 : 10179·116 = \text{the content of the cube} \end{array} \} ; \text{and, by}$$

menſu.

* VI. *Question* 58 *answered by* Moses Bleathman.

> I fee a fault, but can't devife,
> Not for my life, in whom it lies:
> Wheth'r in the author, or the printer,
> Or elfe in me, the fault's amender.
> If I am right, the eldeft fon
> Had twenty-one years over-gone;
> The other fixteen years I fee:
> But this does not with you agree.

Anfwer to the Prize Queftion.

Mr. *Char. Mafon,* Mr. *Tho. Cary,* (who won the prize)
Mrs. *Mary Nelfon,* Mr. *John Cary,* Mr. *Peter Ward,* Mr.
Peirce, Mr. *Witworth,* Mr. *Carrington,* Mr. *J. White,* Mr.
Bleathman

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menfu. $\sqrt[3]{10179\cdot116} = 21\cdot6722 = $ the fide of the cube,

$\sqrt[3]{\dfrac{5089\cdot558}{7\cdot66311896}} = 8\cdot7248 = $ the fide of the dodecaedron,

$\sqrt[3]{\dfrac{1696\cdot518}{\frac{1}{6}\times3\cdot14159\&c.}} = 14\cdot7975 = $ the diameter of the fphere.

Again, for the diameters of the inner ellipfe, or ftone ftep, whofe folidity is $\frac{2}{3}$ of the area of the outer one, and the difference of its diameters $= (276\cdot89248 - 234\cdot03418 =) 42\cdot8583$; let $x = $ half the fum of its diameters, then the diameters will be $x \pm$ $21\cdot41915 \left(= \dfrac{42\cdot8583}{2} \right)$; and their product $x^2 - 21\cdot41915^2$,(per queft.) $= 276\cdot89248 \times 234\cdot03418 \times \frac{2}{3} \times \frac{1}{7} = 8640\cdot304$; hence $x = \sqrt{21\cdot41915^2 + 8640\cdot304} = 95\cdot3914$, and $95\cdot3914$ $\pm 21\cdot4291 = 116\cdot8205$ and $73\cdot9623 = $ the diameters of the inner ellipfe.

* VI. QUESTION 58 *folved.*

Putting x and y for the two ages, we have, per queftion, $x^2 - y = 425$, and $y^2 - x = 235$ (omitting the 3d condition as fuperfluous); hence $y^2 = 235 \times x = \overline{x^2 - 425}|^2$, or $x^4 - 850x^2 - x = -180390$; in which equation $x = 21$, and then $y = x^2 - 425 = 16$.

Bleathman, Mr. *Wilkinfon*, Mr. *Edmund Weaver*, Mr. *R. Hall*, Mr. *Jof. Smith*, anfwered this queftion as below.

	Inches.
The fide of each triangle of the tetrahed	41·853
The perpendicular altitude — —	34·17283136
The fide and altitude of the prifm — —	28·6209
Confequently the fide of the bafe of that Part of the tetra. which is within the prifm. }	28·6209
Its perpendicular altitude — — —	23·3688
Its content in ale-gallons — — — —	9·79793
The perpendicular altitude of the pyramid	5·25204
Its content in ale-gallons — — — —	2·20203
The content of the two pyramids — —	11·99999
Content of the prifm when placed according to the import of the queftion in ale-gall. }	24·0000
The elevation of the prifm — — —	10·8039

Eclipfes

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* P R I Z E   Q U E S T I O N   *folved.*

Since the two ends of the prifm are filled up by two pyramids whofe vertexes meet within it, the height of the two together is juft equal to the alt. of the prifm; and fince a pyramid is $=\frac{1}{3}$ of a prifm of the fame alt. and bafe, it is evident that $\frac{2}{3}$ of the prifm will be filled with liquor, that is, it will contain 24 gallons : which is one part of the demand. The other is to find the additional e-levation of the prifm, which, being evidently $=$ the difference between the altitude of the tetraedron and of the part of it which is let into the prifm, will be found thus.

By the Schol. page 403 Menfuration, $12 \sqrt[3]{6 \times 5\sqrt{2}} =$

$12 \sqrt[3]{30 \sqrt{2}} = 41·853$ inches $=$ the fide of the whole tetraedron ;

and by page 81 and 145, we fhall have $\sqrt[3]{\dfrac{36 \times 282 \times 4}{\sqrt{3}}} =$

$6 \sqrt[3]{\dfrac{188}{\sqrt{3}}} = 28·62092 =$ the fide of the prifm $=$ the fide of the tetraedron which is within the prifm. And it is the difference of the altitudes of thefe two which is required. Now, from the demonftration page 403 Menfuration, it appears that the fide of a tetraedron is to its altitude, as 1 to $\sqrt{\frac{2}{3}}$; and fince the difference $=$ 41·85300 and 28·62092 the fides of the two tetraedrons is 13·23208, we fhall have $13·23208 \sqrt{\frac{2}{3}} = 10·80394 =$ the additio-ion required.

Eclipse of the moon, 1718.

Once this year will the earth's shadow quite hide the body of the moon from our sight, which will be on friday the 29th of august, at 8 at night, being a total eclipse of the moon. The calculation I have lately made, and compared with my former, from *Astronomia Car.*

	h.	m.	s.
The mean ☽ august the 29th, evening — —	8	1	1
The mean anomaly of the earth — —	fig 210	55	2
Of ☽ — — — — — —	010	43	16
Longitude of the sun — — —	♍ 16	34	4
Of ☽ — — — — —	♓ 16	28	37
Difference from the opposition want — —		5	27
Hourly motion of ☉ 2′ 26″, of ☽ 30′ 7″ differ. —		27	31
27′ 31″ to 5′ 27″ :: 60 to the interval, add — —		11	0
The middle or equal time — — —	8	12	1
To which time the sun's place is — —	♍ 16	34	6
☽'s place — — — — — —	♓ 16	34	44
Difference from the opposition past — —			38
Hourly motion of ☉ 2′ 26″, of ☽ 30′ 8″ differ. —		27	42
As 27 42 to 38″ parts :: 60 to interval sub. —		1	23
Equal time of the true ☍ august — — —	29 8	10	38
Subtract ☊ from ☽ place rests argum. last —	6 0	50	33
Reduct. sub. 12″ ☽'s latitude south descend. — —		4	22
From hourly motion of ☽ 29′ 37″ sub. ho. mot.☉ —	2	26
Remains the hourly motion of ☽ á ☉ —		27	11
17′ 11″ to red. 12″ :: 60″ to time of red. add — —			23
Correct time of the true ecliptic opposition —	8	11	1
Semidiameter ☉ 15′ 49″, semidiameter of ☽ —		14	20
Horizontal parallax ☉ 15″, ☽'s 53′ sum — —		53	15
Semidiamet. ☉ subt. remains semid. ☉'s shad. —		37	26
Semediamer ☽ 14′ 20″ add, sum of semidi. — —		51	46
Latitude ☽ subtract, remains parts deficient — —		47	24
14′ 20″ : 6 dig. :: 47′ 24″ parts defic. to dig. —	20	2	0
Interval of ecliptic ☍ and max. obscur. add — —			44
Minutes of incidence and half tarriance — —		51	35
The time of half duration — — —	1	53	51
Equation of time add — — — —		11	53
Apparent time of greatest obscuration — —	7	59	8
Difference of meridians subtract — — —		6	0
Apparent time max. obscuration at Coventry —	7	56	8
Half continuance in total darkness — —		22	41
27. 11. 60. : 22. 41. to half duration in total darkness		50	4
Whole duration in total darkness — — —	1	40	8

Mathem.   P   Hence

Hence the apparent times at London and Coventry.

London.   Coventry.
h. m.   h. m.

6	5	Beginning auguſt 29th evening — —	5 59
7	9	Beginning of total darkneſs — —	7 3
7	59	Greateſt obſcuration — — —	7 53
8	49	End of total darkneſs — — —	8 43
9	52	End of the eclipſe — — —	9 46
3	47	Whole duration	

This type ſhews up-
on the figur'd line of the
moon's way, the time
of the beginning, im-
merſion, greateſt dark-
neſs, emerſion and end,
by the place of the
moon's center on that
line, at her paſſage
through the dark ſha-
dow of the earth :—
the other lines of the
moon's eclipſes, in my
laſt, I explain'd, ſo needleſs here. The moon's latitude at
the beginning is 16 ſeconds north deſcending, and at the end
9′ 38″ ſouth deſcending.*

On the 5th of march, at 3 afternoon, and 13th of ſep-
tember, at 9 morning, moon's eclips'd inviſible. On the
19th of february, at midnight, and 13th of auguſt, at 2 in
the morning, ſun's eclips'd inviſible.

Note, The 20th of auguſt the moon riſes not till 20 mi-
nutes after the beginning of the eclipſe.

                                               Paradoxes

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* *This eclipſe of Aug. 29th was obſerved thus.*

Places	Obſervers	Begin.	To. Im.	Emerſi.	End.
		h. m. s.	h. m. s.	h. m. s	h. m. s.
Padua	Poleni		7 59 4	9 36 4	10 41 2 Ap. time
Bologna	G. Rondelli		7 47 40	9 27 46	10 37 36 Tr. time
Bologna	G. Manfredi	6 42 13	7 47 50	9 29 20	10 38 51 Tr. time
Bologna	V. Giſilieri	6 40 23	7 46 37	9 33 56	10 37 42
London	M. Folkes		7 2 0	8 46 20	9 52 0
Wanſtead	Dr. Pound		7 2 41	8 48 18	9 53 0 Ap. time

Paradoxes to be anſwered next year.

Par. 1. There's a certain country in South America, many of whoſe ſavage inhabitants are ſuch unheard of canibals, that they not only feed upon human fleſh, but alſo ſome of them do actually eat themſelves; and yet they commonly ſurvive that ſtrange repaſt.

Par. 2. There's a certain European city, whoſe buildings being generally of firm ſtone, are (for the moſt part) of a prodigious height, and exceeding ſtrong: yet it is moſt certain, that the walls of thoſe buildings are not parallel to one another, nor perpendicular to the plain on which they are built.

Par. 3. There are two diſtinct places on the continent of Europe, ſo ſituated in reſpect to one another, that tho' the firſt lies eaſt from the 2d; yet the 2d is not weſt from the firſt.

Par. 4. There's a remarkable place on the globe of the earth, of a very pure and wholſome air to breathe in, yet of ſuch a ſtrange and deteſtable quality, that it's abſolutely impoſſible for two of the intireſt friends that ever breathed, to continue in the ſame in mutual love and friendſhip for the ſpace of two minutes of time.

I deſign next year ſome new paradoxes, which I doubt not my correſpondents will compoſe for this place.

New

In this year, from the 18th of January to the 5th of February, new ſtile, a *Comet* was obſerved at *Berlin* by Mr. *Chriſt. Kirk*, thus:

At 10 at night	Longitude		Latitude	
Jan. 18	27° 26′ ♋	69° 18′ No.
21	16	15½ ♉	48	42
23	9	28½	39	45
26	5	25½	32	55
27	4	41	31	24
28	4	4	30	13
30	3	4	28	23½
31	2	43	27	40
Feb. 1	2	25	27	1
2	2	10	26	22
5	1	39	24	53

From theſe obſervations it is found that the comet's deſcending node was in about 21½ degrees of Aries; the angle of its orbit and ecliptic 69½ degrees, it paſſing within 2 or 3 degrees of the pole of the world, and cutting the equator at about 20½ deg. from the equinoctial point; its perigeon was in 6° 6′ ♍ with 67° north latitude, it being in

its perigeon Jan. 18. 3h. 9min.

P 2

New Questions.

I. *Question* 59, *by Mr.* Doidge, *of Portsmouth.*

One ev'ning, as I walk'd to take the air,
I met a damsel beautiful and fair:
Her matchless charms did fix my roving heart,
Which, till that moment, scorn'd love's proudest dart.
Unto this fair I did myself addrefs,
With all the love that lovers can exprefs.
Then ftreight unto her father's houfe we went,
And in love's ftories all the time we fpent.
  A curious garden joined thereunto,
And all that lovely was, i'th' fame there grew:
The filver ftreams, and pleafant walks fo nice,
Made it appear like to a paradife.
  Amidft the garden fhe a knot would place,
The better ftill her garden for to grace.
The content of it fhould exact agree,
To be in feet one hundred fixty-three:
A polygon's the form; but it muft bear,
Of juft ten equal fides, and regular.
  Then fir, faid fhe, pray try your fkill to find
The fide's true length, to form the knot defign'd.
And to reward the pains you take for me,
I freely then your wedded wife will be.
Thefe words with joy fo fill'd my breaft, that I
Thought that each moment was eternity,
Until that I the fide's true length had found,
And then in pleafure evermore abound.
But ah! with pains I've try'd all ways about,
And all in vain; I cannot find it out.
    Affift, fair ladies, one with grief oppreft,
    And fend an anfwer to this one requeft.

II. *Question* 60, *by Mr.* Tho. Cary, *of Lynn.*

Within my garden I've a pond that's round,
Whofe furface equal to 5028$\frac{4}{7}$ fquare feet is found:
In th' midft of which, a pole ftands juft upright
Above the plain, one hundred feet in height:
This pole being broke into two parts,
Come, tell this query now, ye men of arts.
The broken piece fell juft at the pond's brink:
How long is then the piece left, do you think?

III. *Queſtion 61, by Mr.* Peter Ward.

You that delight in figures, try your ſkill,
A magic ſquare with numbers for to fill.
One to a hundred numbers there muſt be;
Which to the numbers of the ſquares agree:
But farther ſtill you muſt them ſo contrive,
Twenty-two ways to make five hundred and five,
No two ſquares alike in numbers muſt be;
But ten in length, and ten in breadth, let's ſee.

IV. *Queſtion 62, by Mr.* Wm. Whitworth, *of Northampton.*

Ingenious ſons of art, I new requeſt,
That you my artificer will aſſiſt.
Alſo be pleas'd to let me underſtand,
How to effect my purpoſe now in hand.
  A ciſtern made of lead that's half inch thick,
In oblong priſm form; but honeſt Dick
With me agreement made the length to be
In ratio to the breadth, as five to three;
And muſt hold fifty buſhels exactly.
  But this is what I moſt of all deſire,
To have it, that the leaſt lead will require;
That is, what will the leaſt of ſurface have,
Is what from you, I with ſubmiſſion crave.
Alſo its length and depth to me expound,
And what 'twill coſt at three half pence a pound.

V. *Queſtion 63, by Mr.* Lewis Evan, *from Carmarthenſhire*

Ten partners bought the hay next year to grow
Upon the meadow field deſcrib'd below.
The price is forty pounds. The mead contains
Juſt ſixty acres, or ſix hundred chains.
A pays a ſum to be found out, and *B*
Does pay five ſhillings more than *A*; ſo *C*
Five ſhillings more than *B*; the ſame exceſs
Continues to the end; nor more, nor leſs.
  Three ſides it has, whereof the baſe is fifty,
O'th' two ſlope lines, the longeſt meaſures forty,
The other thirty chains. This mighty care
Torments their minds, how ev'ry one's due ſhare
According to the money he pays in,
Shall be laid out by 'tſelf. For they begin
To think, no other way will do ſo well;
That partnerſhips are tedious, moſt can tell.

At the acuteſt angle, they've indeed
Amongſt themſelves moſt willingly agreed,
A's ſhare ſhall be, the reſt in order on,
B, C, D E, ſo forth, till all is done;
Thoſe perpendicular lengths, which from the baſe,
Erected at right angles, ſhall thoſe ſhares
Divide aſunder: and how many chains
O'th' baſe each ſhare takes up: Whoe'er the pains
Shall take to ſhew, himſelf may well aſſure,
He ſhall thereby their heartieſt thanks procure.

VI. *Queſtion* 64, *by Mr.* Rob. Beales.

A young man had left him by his old grannum
Two hundred pounds; but nothing per annum.
'Twas not to be paid him till nine years three quarters,
Which vexed him ſore, and put him to tortures;
'Cauſe being juſt marry'd, he wanted the pelf,
Which made him bethink what to do with himſelf.
So he went to a miſer, whoſe riches were great,
And did the whole ſtory unto him relate;
Who ſaid, if his ſtory in truth could be found,
He'd venture to give him one hundred pound
Then down on the nail; which made him look brave,
And tell the old lurch, the full ſum he ſhould have,
As above, at the time: ſo ſecur'ty was made,
And an hundred pounds he had got for to trade.
Now what compound int'reſt did the miſer demand,
Per cent. per annum for the money in hand?

The Prize Queſtion, 10 *diaries to the anſwerer.*

Ladies, as you ſet many right,
Pray do the ſame for a wheelwright;
And for your pains I will content you,
If you explain this paper ſent you.
In two wheels if there be inſcribed
A polygon that's equal ſided;
The leſs five ſides, the other ſeven;
Of which the areas they are given
In proportion or analogy,
Exactly as thirteen to three.
But theſe to find, depends upon
The juſt length of a pendulum
That vibrates ſixty times and one
Exactly in one minute's ſpace:
This, being found, is the true baſe

To two fides of the pentagon;
And bounds the angle (which is known).
Then by the length of this fubtenfe,
Or bafe, there will by inference,
Be found the parts of ev'ry figure,
Firft of the lefs, and then the bigger:
Alfo each wheel's periphery;
For that directs the fmith and me.
   And for that lady's courtefy,
Who firft fends thefe true lengths to me,
I'll give next year ten ladies' diaries,
As prize for anfwering thefe queries.

1719.

Anfwers to the Paradoxes propofed laft year.

Par. A Draftea fays, If they don't eat (their meat) them-
1. ⎯ felves, who can eat for them, in fuch manner as
to fuftain their life?

Par. 2. All walls are endeavour'd to be built perpendi-
cular to the tangent (and point to the center) of the earth,
where they, if continued, would meet in a point, and confe-
quently are not parallels, and but in one point only can a
perpendicular be raifed on a horizontal plain: vid. 5th par.
1715, anfwer'd in the diary for 1716, and *Euclid.* lib. 11 pr. 13.

Par. 3. Any two places on the globe that differ in, or
have latitude.

Par. 4. This paradox by fome anfwer'd thus. 'Tis im-
poffible for two perfons to be in one and the felf-fame indi-
vidual place together.

Others fay, two in the throne can't continue in mutual
love and friendfhip.

Mr. *Hum. Marfhjuftum* fays, by reafon of the earth's
motion they cannot continue in the fame air.

VI. *The 64th question resolved by* A. Philomathes, T. Dodd, Lewis Evan, W. Crabb, J. Smith, W. Hawney, W. Armstrong, W. Loughton, J. Jennings, C. Chorley, Anne Harris, J. Tefft, *and several others.*

The miser demanded $7 l.\ 7 s.\ 4\frac{1}{4} d.$ per cent. per ann. comp. int.

The

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term $a = \dfrac{2 s - d n \cdot \overline{n - 1}}{2 n} = \dfrac{1600 - 450}{20} = 57\frac{1}{2} s. = 2 l.\ 17 s.$ $6 d. = A's$ share of the money, and by the constant addition of $5 s.$ all the rest will be found to be as in the 2d column of the original solution above.

Then, their shares of the field will be in proportion as their sums of money, and since the triangle is evidently right angled, and its area $= 30 \times 20 = 600$ chains $= 60$ acres, we shall have, as $40 l.$: 60 acres or as $2 : 3 :: 2 l.\ 17 s.\ 6 d. : 4\cdot3125$ acres $= 4 a c.\ 1 r o.$ 10 poles $= A's$ share, and as $2 l. : 3 :: 5 s. : \cdot375\ a c. = 1 r o.\ 10 p o.$ $=$ the common difference; which being continually added will give the several shares as in the 3d column.

Again, for the bases and perpendiculars : Since the first and last parts are triangles similar to the whole field, and similar triangles being as the squares of their like sides, we shall have, as

$\sqrt{60} : \sqrt{4\cdot3125} :: \begin{cases} 40 : 10\cdot723 = A\text{'s base} \\ 30 : 8\cdot042 = A\text{'s perpendicular,} \end{cases}$

and $\sqrt{60} : \sqrt{7\cdot6875} :: \begin{cases} 40 : 14\cdot317 = K\text{'s perpendicular} \\ 30 : 10\cdot738 = K\text{'s base.} \end{cases}$

Then to the first and last areas add their adjacent ones, and the sums will be the next similar triangles; whose sides being calculated in the same manner, their perpendiculars will be those in the last column, and the differences of the bases will be the bases in the column next to it.

VI. QUESTION 64 *solved.*

If r be put for the rate of $1 l.$ by the nature of compound interest, we shall have $100 \times \overline{1 + r}\vert^{\frac{39}{4}} = 200$, or $\overline{1 + r}\vert^{\frac{39}{4}} = 2$, or $\overline{1 + r}\vert^{39} = 2^4 = 16$; and $r = 16^{\frac{1}{39}} - 1 = \cdot07368.$ Hence the rate per cent. is $100 \quad \cdot07368 = 7\cdot368 = 7 l.\ 7 s.\ 4 d.\ 1\cdot28 q.$

The Prize Question answered by Anna Philomathes, W. Hawney, Josiah Clayton, J. Buckey, Philomathematica, Luke Cullimore, Mary Nelson, Jo. Smith, E. Elphick, C. Mason, T. Orme, Henry Hale, J. Jennings, Ja. Pearce, W. Doidge, Cha. Chorley, Anne Harris, *and* W. Whitworth, *before Candlemas-day, and afterwards by* Tho. Cary, J. Cary, G. Hare, J. Stocks, R. Whitehead, Beata White, *and* Peter Ward.

W. Whitworth's *answer.*

The lengths of pendulums are reciprocally proportionable to the squares of their vibrations.

Therefore as fq. $61 = 3721 : 3600 :: 39^{\cdot}2 : 37^{\cdot}9252 = b$ the subtenfe, whence the fide a muft be found by this theorem : *If a quadrangle be inscribed in a circle, the rectangles of the two diagonals will be equal to both the rectangles of the opposite fides.*

Now the diagonals being each equal to the subtenfe b, the theorem is $aa + ba = bb$; ergo, $a = \sqrt{bb + \frac{1}{4}bb} - \frac{1}{2}b = 23^{\cdot}439062$ inches, the fide of the pentagon.

Then b being the hypothenufe of a rectangle triangle defcribed in a circle, and cd part of the diameter (as far as where the perpendicular falls) the bafe; the perpen. being a and the other part of the diam. df; we have $\sqrt{bb - \frac{aa}{4}}$ $= cd$; and $\frac{1}{4}aa \div cd = df$; and $cd + df =$ diamet. required. Alfo the area of the pentagon will be $945^{\cdot}210782$. Then $3 : 13 :: 945^{\cdot}2107 : 4095^{\cdot}9133912 =$ area of heptagon, $3^{\cdot}633912 : 1 :: 4095^{\cdot}91$ in duplicate ratio, to fide of the heptagon. Then the other parts are eafily found, as below.

Parts.		Pentagon.		Heptagon.
The area of the ———	—	$945^{\cdot}2107$	—	$4095^{\cdot}9133$
Diam. of circum. circle	—	$39^{\cdot}8768$	—	$76^{\cdot}8283$
Diam. of infcribed circle	—	$32^{\cdot}2611$	—	$69^{\cdot}1047$
Circumfcribing circle —	—	$125^{\cdot}2768$	—	$241^{\cdot}3637$
Infcribed circle — —	—	$101^{\cdot}3510$	—	$217^{\cdot}0994$

Of the Eclipses in 1719.

Four times this year, in their natural course, will the sun and moon be deprived of giving light to us; the calculation I have supputated form *Astronomia Carolina*, the tables of the celebrated Mr. *Tho. Street.*

1. Sun eclipsed the 8th day of february, at 6 o'clock in the morning, the sun being then not risen, can't be seen by us in the british islands, but in the eastern countries it will be a considerable deliquium.

2. Moon eclipsed on the 23d. of february, at 50 min. after 7 in the morning, but the sun rising half an hour before 7, the moon consequently must be set, as being then diametrically opposite, so the moon immerges just as the eclipse begins, and makes it invisible to us; but to the Western islands it will appear 5 digits eclipsed on her southern limb.

3. Sun eclipsed on tuesday the 4th day of august, at 6 in the afternoon; but it may be invisible, the moon's south latitude so depresses her as not to interpose between the sun and our sight.

4. Moon eclipsed, and visible on tuesday the 18th day of august, at 8 o'clock in the evening.

	h.	m.	s.
The equal time of the true ☍ at Coventry — —	7	44	3
The time of reduction add — — — —		3	23
Correct time of true ☍ in the ecliptic — —	7	47	26
Æquation of time add — — — —		2	36
The apparent time of ☍ — — — —	7	50	2
Interval of the true ☍ and the greatest obscur. sub.		6	46

Hence at Coventry, August 18th evening.

	m.	h.
The beginning — — — — —	VII	18
The middle or greatest obscuration — —	VIII	15
The end — — — — — —	IX	13
The whole duration — — — —	I	55
Digits eclipsed north — — — — 3 D. 3'. 42″.
The latitude of the moon at beginning — 42'. 55″. S. D.
Latitude at the end, 48' south descending.

It would be much for the improvement of aſtronomy, and honour of our nation, if perſons who have well adjuſted pendulums and proper inſtruments, would obſerve the times and parts of the eclipſes, and communicate them; that eclipſe of ☽ 9 ſept. 1717, was obſerved in latitude 55 to be obſcured about 7 digits.

The three obſervations following were made and adjuſted to the city of Coventry by an accurate hand.

1717. Oct. 9 d. 13 h. 12′ 40″ Jupiter's 3d ſatellite emerged.
1717. Dec. 5   9   22   00 Jupiter's 2d ſatellite immerg.
1717. Jan. 28   7   16   40 Jupiter's 1ſt ſatellite emerged.

New Paradoxes.

1. There are divers places on the continent of Africa, and the iſlands of Sumatra and Borneo, where a certain kind of ſun-dial being duly fix'd, the gnomon thereof will caſt no ſhadow at all, during ſeveral ſeaſons of the year; and yet the exact time of the day may be known thereby.

2. There is a certain iſland (whereof mention is made by ſeveral of our lateſt geographers) whoſe inhabitants cannot properly be reckoned either male or female, nor altogether hermaphrodites: yet ſuch is their peculiar quality, that they're ſeldom liable to either hunger or thirſt, cold or heat, joy or ſorrow, hopes or fears, or any ſuch of the common attendants of human life.

3. There is a very remarkable place upon the terraqueous globe, where all the planets, notwithſtanding their different motions and various aſpects, do always bear upon one and the ſame point of the compaſs.

4. There is a large and famous country on the continent of Africa, many of whoſe inhabitants are born perfectly deaf, and others ſtone-blind, and continue ſo during their whole lives; and ſuch is the amazing faculty of thoſe perſons, that the deaf are as capable to judge of ſounds, as thoſe that hear, and the blind of colours, as thoſe that ſee.

5. *Scholaſticus* ſends the following in latin, out of *Owen*'s epigrams.

Dic quibus hoc animal terræ naſcatur in oris,
    Maſculus eſt matur cui, mulierque pater.

New Questions.

I. *Question* 65, *by Mr.* Henry Walker.

When firſt *Columbus,* with advent'rous mind,
The ocean croſs'd, a weſtern world to find,
With him a gentle Spaniard, young and fair,
Saw, and confeſs'd the power of beauty there:
An Indian virgin firſt engag'd his love;
She innocent, his paſſion did approve;
And crown'd the happy lover, I am told,
With native beauty, and with native gold.
A wedge of gold (herſelf the lovelier prize)
She brings; whoſe length and depth who multiplies,
Produces ninety-ſix; the breadth by depth fourſcore,
The length by th' breadth one hundred twenty more.
The ſides true meaſures, what, I do demand;
And would the wedge's value underſtand?

II. *Question* 66, *by Mr.* W. Doidge.

In the latitude of 50 forty-eight,
I ſaw a rainbow beautiful and bright;
It bore north-eaſt, three quarters eaſt, as I
By all my care and art could beſt deſcry.
What was it of the clock I fain would know,
And beg that you the ſame to me would ſhow.

III. *Question* 67, *by Mr.* W. Hawney.

What number of * guineas and piſtoles, I pray,
(With no other coin) will one hundred pounds pay?
And how many ways? Pray declare unto me;
And I'll give you a pot whene'er I you ſee.
  * Guineas at 21 *s.* 6 *d.* piſtoles at £17 *s.*

IV. *Question* 68, *by Mr.* John Leddell.

Within my garden I've a piece of ground,
A circle's arch that is exactly round:
This arch's ſine, in length juſt 30 feet;
Its verſed ſine in length is ten compleat.
Now I would have this arch continued round,
Till the ſine's length forty five feet is found.
Ye men of arts, now to oblige your friend,
Of this new arch's verſed ſine the length pray ſend.

V. *Question*

V. *Queſtion* 69, *by Mr.* Jo. Smith.

Three countrymen in Lincolnſhire,
   A meadow ground did buy
For nineſcore pounds; to their deſire,
   In oval form did lie.
The conjugate was forty chains,
   The focus point was found
Juſt fifteen chains, by mighty pains,
   From th' center of the ground.
Now *A* would in the middle be,
   And *Y*'s abſciſſa were
Juſt eighteen chains; whereas that *E*
   His ordinate was near
To thirty chains rightly apply'd.
   Now what ſhall each man pay?
And how much land? I pray, don't hide
   Such things as needful be.

VI. *Queſtion* 70, *by Mr.* J. Dodd.

As viſiting a friend, the other day,
Tho' unprepar'd, I then muſt needs ſurvey
A piece of land, exact triangular;
One ſide of which I only cou'd come near:
Quoth he, This angle once was found to be
Thirty degrees, and minutes forty-three:
The ſides including it when multiply'd
Together, will (if that be any guide)
I formerly have heard, exactly give   * 168·75
In chains * eightſcore and eight, tenths ſeventy-five.
Th' aſſiſtance only of Sir *Jonqs Moore*,
Thro' his compendium, I could then procure;
Without the help of any inſtrument,
I'd have the rule to find out the content.

VII. *Queſtion* 71, *by* Alex. Naughley, *of Cumberland.*

A ſtone for a hog-trough, I'd have to contain
Inches five thouſand four hundred; and then
Its length, breadth, and depth, to the ſum muſt amount
Of fifty-ſeven inches, as houſwives account;
And the trough muſt be made exactly to hold
Five Wincheſter pecks; or I'm ſure of a ſcold.
So pray, you fair ladies, ſend me what directions
The workman may want, to find the dimenſions:
Or what they muſt be (like within as without)
An't pleaſe you to ſhow, it will bring us both out.

VIII.· *Quefiion* 72, *by Mrs.* Mary Nelfon.

A captain on the feas, who was both brave and bold,
Had taken from his foes a cheft well fill'd with gold;
Then all his men were call'd; he ftraightway let them know,
That each fhould have his fhare, as is exprefs'd below.
Now, ladies, anfwer this: How many men there were,
And how much money each allotted to his fhare?
　The firft took one pound and a hundredth part of the re-
mainder. The 2d two pounds and two of the remainder,
and fo on, till the laft man, who had all that was left. So
the money was equally divided. If the number of men were
added to the number of pounds in each fhare, the fquare of
that fum would be equal to four times the number of pounds
they had in the cheft.

IX. *Quefiion* 73.

Show me how to find, what's the leaft number
That you can divide without a remainder?
By given divifors? As the digits nine;
For a true cannon, I'd give a pint o' wine.

X. *Quefiion* 74, *by Mr.* Crabb.

Let the dimenfions of a fpheroid cafk
Be fuch as here are under; then I afk
The difference in wine gallons, that are
Between the greateft cube and cylinder
That can be infcribed in the fame. Pray try;
And let us know in your next diary.
　　Diameter at the head 31'8 ⎫
　　Diameter at the bung 40　⎬　inches.
　　Length　—　　—　52'8 ⎭

The Prize Quefiion.

The anfwerer may by lot win 10 *of thefe diaries.*

Ladies, I have a wager laid,
Which I fhall lofe without your aid:
In Turner's yard lay a wheel nave,
Which late was turned in his lathe,
And is, in fhape, a fpheroid's fruftra;
But for the axeltree, there muft a
Hole be made, whofe vacuity⎫
The fruftum of a cone muft be;⎬
And bafe breadths in analogy,⎭

Or

Or ratio, fixed is and certain,
Being as twice eight is to thirteen;
And the length in inches eighteen.
The hole being made of this said form,
A gallon is to hold of corn,
And two tenths more of cubic inch.
Pray, ladies, help me at this pinch,
And tell the breadth each bafe muft be.
To find the nave's folidity,
Four times the breadth of the bigger bafe
Of the cone's fruftra (in this cafe)
Is the greateft thicknefs of the nave;
Thrice the faid breadth each end muft have.
Now, ladies, I moft humbly crave
Your help in the next diary,
To fend me the folidity;
And alfo the periphery
O'th' hoops that this nave environ
Four inches from each end (of iron).
Having your help, I'm yours till death,
And you'll oblige each philomath.

1720.

Paradoxes anfwered.

Par. A Horizontal dial under the equinoctial line cafts no
  1. shadow at 12 o'clock twice every year.

Par. 2. If puppets may be called inhabitants, it will an-
fwer this paradox.

Par. 3. Under either of the poles of the world.

Par. 4. The blind and deaf have capacity to judge of co-
lours and founds as well as thofe that fee and hear, tho' they
want the fenfes of feeing and hearing.

Par. 5. Progenitos vidi numerofus vere * Gyrinos
      Hæc rana, hic bufo; mater hic, illa pater..

          * A tadpole, young frog, or toad.

Solutions to the quefrions.

* I. *The 65th queftion anfwer'd.*

A wedge of gold delightful to the eyes,
The charming fair was much the greater prize.

Tho' this queftion was falfe printed (breadth for depth)
in the 10th line, yet the true anfwer was given by feveral,
but with fome variety as to the value of the gold, as either
ftandard, pure, or allay'd. The length 12, breadth 10, and
depth 8 inches, and if ·10083 inch. = 1 ounce, and the troy
pound = 42 *l.* 10*s.* the value was 33718 *l.* 19 *s.* 9¼ *d.*

† II. *Queftion* 66, *anfwered by* William Armftrong.

If the fun was near the equinox, which is unlimited in the
queftion, it was 33 min. 45 feconds paft 3 evening.

III. *Queftion*

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* I. QUESTION 65 *folved.*

From the queftion it is evident that the breadth is to the length
as 80 to 96, or as 5 to 6, and to the depth as 120 to 96 or as 5 to 4.
Now the product of 4 and 5 is 20, which is fimilar to the product
80 in the queftion; and each of the proportional numbers 4, 5,
6 will be to the correfponding numbers required, as the root of 20
to the root of 80. Wherefore as ($\sqrt{20} : \sqrt{80} :: \sqrt{1} : \sqrt{4} ::$)

$$1 : 2 :: \begin{cases} 4 : & 8 = \text{the depth,} \\ 5 : & 10 = \text{the breadth,} \\ 6 : & 12 = \text{the length.} \end{cases}$$

Hence the content is $8 \times 10 \times 12 = 960$ inches. And, ufing
Ward's tables, $960 \times 10\cdot359273$ ounces $= 80 \times 10\cdot359273 =$
$828\cdot74184$ *lb.* which at 22 *l.* 10*s.* per *lb.* amount to 35221 *l.* 10*s.*
6 *d.* 3·0724.

† II. QUESTION 66.

In the above original folution to this queftion, it is juftly re-
marked that the queftion is unlimited, as the declination or time of
the year fhould have been given, and then the folution would have
been very eafy : For as the rainbow is formed directly oppofite to
the fun with regard to the obferver, the bearing of the fun will be
S. W ¼ W. fo that in a fpherical triangle would be given two fides
(= the colat. and codeclin.) and an angle (the fun's azimuth or
bearing from the north) oppofite to one of them (the codeclin.),
find their included angle = the meafure of the time from noon
ed.

* III. *Queſtion* 67, *anſwer'd by* Mrs. Heſychia.

> Guineas ten, forty-four, and ſeventy-eight,
> (As I do take it) ſet the matter right;
> An hundred and five, ſixty-two, nineteen,
> Are all the piſtoles to anſwer each guin.

† IV. *Queſtion* 68 *anſwered.*

The verſed ſine's length 28·2055 feet.

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* III. QUESTION 67 *ſolved.*

Put x and y for the number of guineas and piſtoles reſpectively, then the number of ſix-pences in them being $43x$ and $34y$, and the ſix-pences in $100 l. = 4000$, we ſhall have $43x + 34y = 4000$; hence $x = \frac{4000 - 34y}{43} = 93 - \frac{34y-1}{43} =$ a whole number; conſequently $\frac{34y-1}{43}$ as alſo 5 times the ſame, viz. $\frac{170y-5}{43}$ $=$ a whole number; take this from the whole number $\frac{172y}{43}$ $= 4y$, and there remains the whole number $\frac{2y+5}{43}$; from 22 times this whole number, viz. $\frac{44y+110}{43}$, take the whole number $\frac{43y}{43} = y$, and there remains the whole number $\frac{y+110}{43}$, which put $= p$; then $y = 43p - 110$, where the leaſt value of p is evidently 3. Subſtitute this value of y in the value of x, and we ſhall have $x = \frac{4000 - 34y}{43} = 180 - 34p$, in which the greateſt value of p is evidently 5. So that the queſtion admits of only three ſolutions, p having only three values, viz. 3, 4, and 5; and by writing each of theſe numbers for p in the values of x and y, we obtain $x = 78$, 44, and 10, and $y = 19$, 62, and 105.

† IV. QUESTION 68 *ſolved.*

The right ſine being 30, and verſed ſine 10, by the nature of the circle, the diameter will be $10 + \frac{30^2}{10} = 100$, and conſequently the radius $= 50$. But, by right-angled triangles, the coſine of the arc whoſe right ſine is 45, will be $= \sqrt{50^2 - 45^2} = 5\sqrt{10^2 - 9^2} = 5\sqrt{19} = 21 \cdot 7944947$ &c. which being taken from the radius 50, there remains $28 \cdot 205505$ &c. for the verſed ſine required.

* V. *Queſtion* 69 *anſwered.*

In the 9th line of this queſt. the error of [not] inſtead of [in] quite alter'd the deſign; otherwiſe the anſwer had been,

A's part 96·65864 pounds
E ——— 25·19722
T ——— 58·14413

† VI. *Queſt.* 70, *anſwer'd by Mr.* John Finch, *of Norwich.*

As rad. : to S. giv. angle :: ¼ the rectang. giv. : to area 4 *a.* 1 *r.* 9 *p.*

VII. *Queſ-*

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* V. QUESTION 69 *ſolved.*

By the right-angled triangles, the diſtance between the focus and the end of the conjugate will be $\sqrt{20^2 + 15^2} = 25 =$ the ſemi-tranſverſe by the nature of the ellipſe; then, by caſe 2 p. 225

Menſuration, $25 - \dfrac{25\sqrt{20^2 - 15^2}}{20} = 25 - \dfrac{25\sqrt{4^2 - 3^2}}{4} =$

$25 - \dfrac{25\sqrt{7}}{4} = 8·4640543$ &c. $=$ the abſciſſa of E's part.

Now $\dfrac{8·4640543}{50} = ·169281$, and $\dfrac{18}{50} = ·36$; but the tabular areas for theſe two quotients, in the table of ſegments at the end of my Menſuration, are ·08799586 and ·25455055, whoſe ſum taken from ·78539816, there remains ·44285175. Alſo the product of the two axes $= 50 \times 40 = 2000$

Then, by rule 2 p. 244 Menſur. we ſhall have
·08799586 × 2000 $=$ 175·99172 $= E$'s part ⎫
·25455055 × 2000 $=$ 509·10110 $= T$'s part ⎬ in ſquare chains ;
·44285175 × 2000 $=$ 885·70350 $= A$'s part ⎭
their ſum being 1570·79632 $=$ ·78539816 × 2000 $=$ the area of the whole ellipſe.

Alſo, by proportion, we have as 1570·79632 : 180 *l.*

:: ⎧ 175·99172 : 20·1672 *l.* $=$ 20 *l.* 3 *s.* 4 *d.* 0·512 *q.* $= E$'s money,
⎨ 509·10110 : 58·3387 $=$ 58 6 9 1·152 $= T$'s,
⎩ 885·70350 : 101·4941 $=$ 101 9 10 2·336 $= A$'s.

180 0 0 0 ſum.

So that the numbers in the original ſolution are falſe.

† VI. QUESTION 70 *ſolved.*

By a known rule for the area of a triangle, we have as 1 : ·510793 (*the nat. ſine of* 30° 43′) :: 84·375 $=$ half the product of the including ſides : 43·09817 chains $=$ 4 *a.* 1 *r.* 9·5707 perches.

* VII. *Queſtion 71, anſwered by Mr.* Nath. Brown, *writing-maſter at Sleeford, in Lincolnſhire.*

$$\left.\begin{array}{ll}\text{Length} & 30 \\ \text{Breadth} & 15 \\ \text{Depth} & 12\end{array}\right\} \text{ inches without } \left\{\begin{array}{l}25{\cdot}777 \\ 11{\cdot}888 \\ 9{\cdot}511\end{array}\right\} \text{ within.}$$

† VIII. *Queſtion 72 anſwered.*

The men were 99, and had 99 l. each. The whole 9801 l.

IX. *Queſ-*

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* VII. Q u e s t i o n 71 *ſolved.*

Put *x, y, z* for the length, breadth, and depth of the ſtone re-ſpectively : Then, by the queſtion, $x + y + z = 57$, and $xyz = 5400$. The queſtion then is unlimited, there being one equation leſs than the number of unknown quantities. We ſhall there-fore aſſume another condition, viz. we ſhall ſuppoſe the length to be double the breadth, or $x = 2y$: Then, this written for it in the two given equations, we have $3y + z = 57$, and $2y^2z = 5400$.

Hence $z = 57 - 3y$, which written for it in the laſt equation, we have $114y^2 - 6y^3 = 5400$, or $19y^2 - y^3 = 900$. Here $y = 15$. Conſequently $x = 2y = 30$, and $z = 57 - 3y = 57 - 45 = 12$.

Then, ſince 5 pecks $= 10 \times 268{\cdot}8 = 2688$ inches, and ſimilar ſolids are as the cubes of their like ſides, we ſhall have as $\sqrt[3]{5400}$: $\sqrt[3]{2688}$ or as $\sqrt[3]{225}$: $\sqrt[3]{112}$ or as $\sqrt[3]{3375}$: $\sqrt[3]{1680}$, that is, as

$$15 : 2\sqrt[3]{210} :: \left\{\begin{array}{l}30 : 4\sqrt[3]{210} = 23{\cdot}77568 \\ 15 : 2\sqrt[3]{210} = 11{\cdot}88784 \\ 12 : \tfrac{8}{5}\sqrt[3]{210} = 9{\cdot}51027\end{array}\right\} = \text{the dimenſions}$$

of the hollow.

† VIII. Q u e s t i o n 72 *ſolved.*

Put *x* for the number of pounds in the cheſt : Then, by the queſtion, $1 + \dfrac{x-1}{100} = \dfrac{99+x}{100} = $ the firſt man's ſhare, and con-ſequently the ſum afterwards left $= x - \dfrac{99+x}{100} = \dfrac{99x - 99}{100}$;

* IX. *Queſtion* 73 *anſwer'd by Mr.* Tho. Fletcher.

Moſt readily, ſir, I'll the number divulge,
Which the margin makes plainly appear.   2520
I'll the canon reſerve till I taſte of your wine:
Pray obſerve, I'm ſchoolmaſter of Ware.

Mr. *Naughley* gives this canon; multiply the higheſt given powers together, and their products continually by every ſuch given prime, as is no component of any of the ſaid powers, or their product, or of any other given prime : So $9 \times 8 \times 7 \times 5 = 2520$ required.

X. *The*

again, the 2d man's ſhare will be $2 + \dfrac{\frac{99x - 99}{100} - 2}{100} =$

$198 + \dfrac{\frac{99x - 99}{100}}{100} = \dfrac{19701 + 99x}{10000}$, which muſt be $=$ that of

the former, that is, $\dfrac{99 + x}{100} = \dfrac{19701 + 99x}{10000}$; hence $9900 + 100x$

$= 19701 + 99x$, and $x = 19701 - 9900 = 9801 =$ the number of pounds in the cheſt. And $\dfrac{99 + x}{100} = 99 =$ each man's ſhare.

Again, putting $z =$ the number of men, by the queſtion it will be $\overline{z + 99}|^2 = 4 \times 9801$; hence, by extracting the root, $z + 99 = 2 \times 99$, and $z = 99 =$ the number of men the ſame with the number of pounds in each man's ſhare.

* IX. QUESTION 73 *ſolved.*

The general rule for this kind of queſtions, is to begin with the greateſt number and deſcend gradually to the leaſt, taking the continual product of them ; but omitting ſuch of the leſs numbers or of their factors as are factors of any of the greater ones. So, in this example, 9 muſt be uſed as being the higheſt number; 8 muſt be uſed becauſe neither itſelf nor any of its factors 2, and 4, are factors of 9; 7 muſt be uſed becauſe it is no factor either of 9 or 8; 6 muſt be omitted becauſe one (3) of its factors divides 9, and the other (2) divides 8 ; 5 muſt be uſed as being no diviſor of either 7, 8, or 9; but 4 muſt be omitted as being a factor of 8, 3 muſt be omitted as being a factor of 9, and 2 omitted as being a factor of 8. The reaſon of all which is extremely obvious.

Then $9 \times 8 \times 7 \times 5 = 2520 =$ the leaſt number required.

* X. *Queſtion* 74 *reſolved by Mr.* T. Hill.

As you are Crabb by name, I think by nature too,
  I your crab do taſte at laſt, but 'tis with much ado.

  The content of the cylinder 182·2503, of the cube 84·2645;
the difference in wine gallons 97·9858.

<div align="right">The</div>

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* X. QUESTION 74 *ſolved.*

Let CB be half the length
of the caſk, CE and CG half
the height of the cylinder and
cube reſpectively; draw the
ordinates EF, GI, and to the
point F draw a tangent meet-
ing the ſemi-tranſverſe CA,
and ſemi-conjugate CD, pro-
duced, in T and K.

  Then, by p. 209 Simpſon's
Geom. 2d edit. the ſub-tangent
is twice the altitude of the grea-
teſt cylinder, that is, $ET =$
$2 EC$; hence $CT = 3 CE$, and
$CK = \frac{1}{2} EF$: but, by the na-

ture of the ellipſe, $\begin{cases} CE : CA :: CA : CT \text{ or } 3 CE \\ EF : CD :: CD : CK \text{ or } \frac{1}{2} EF \end{cases}$ hence CE

$= CA\sqrt{\frac{1}{3}}$, and $EF^2 = \frac{2}{3}CD^2$: but, alſo by the ellipſe,

$\sqrt{CD^2 - BH^2} : CB :: CD : CA = \dfrac{CD \times CB}{\sqrt{CD^2 - BH^2}}$; and

therefore CE (or $CA\sqrt{\frac{1}{3}}$) $= \dfrac{CD \times CB}{\sqrt{3 CD^2 - 3 BH^2}}$. Hence the

ſolidity of the whole greateſt cylinder will be $2 CE \times EF^2 \times$

$3\cdot14159$ &c. $= \dfrac{4 CD^3 \times CB}{\sqrt{3 CD^2 - 3 BH^2}} \times \dfrac{3\cdot14159 \text{ &c.}}{3} =$

$\dfrac{203 \times 26\cdot4 \times 4}{\sqrt{3\cdot20^2 - 3\cdot15\cdot9^2}} \times \dfrac{3\cdot14159 \text{ &c.}}{3} = 42100\cdot05.$

  Again, CG being half the ſide of the cube, and GI the radius
of a circle circumſcribing one face of it, the ſquare of the ſide of
the cube or $4 CG^2$ will, by right-angled triangles, be $= 2 IG^2$;
and hence $IG^2 = 2 CG^2$: but, by the ellipſe, $CA^2 : CD ::$
$CA^2 - CG^2 : GI^2$ or $2 CG^2$; hence $\sqrt{2 CA^2 + CD^2} : CD$
$:: CA : CG = \dfrac{CA \times CD}{\sqrt{2 CA^2 + CD^2}} = $ (by writing the value of CA

The Prize Question answered by Mr. Whitworth.

Put $b = 13$, $c = 16$, $l = 18$ the length, $d = 269$ the content, $g = \cdot 78539$ &c. $a =$ lesser base's diam. Then $b : c :: a : \frac{ca}{b}$ $=$ greater base's diam. Now the area of the greater base, lesser base, and a geometrical mean multiply'd by $\frac{l}{3} = d$,

the content, that is $\overline{aag + \frac{ccaag}{bb} + \frac{aagc}{b}} \times \frac{l}{3} = d$,

which reduced is $ccaa + bbaa + bcaa = \frac{3dbb}{gl}$: by this equation

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instead of it) $\dfrac{CD \times CB}{\sqrt{CD^2 + 2CB^2 - BH^2}}$; whose cube is

$\dfrac{20^3 \times 26 \cdot 4^3}{20^2 + 2 \cdot 26 \cdot 4^2 - 15 \cdot 9^2 \vert^{\frac{1}{2}}} = 19464 \cdot 41 =$ the content of the cube.

The difference of these two contents is $22635 \cdot 64$ inches $= 97 \cdot 9898$ wine gallons $=$ the difference required.

* PRIZE QUESTION *solved.*

Putting $16x$ and $13x$ for the diameters of the ends of the conic frustum, and $n = \cdot 785398$ &c. by cor. 6 p. 156 Mensur. we shall have the content of it $= \overline{16 + 13\vert^2 - 16 \cdot 13} \times x^2 \times \dfrac{18n}{3} = 269$

by the question; hence $x = \sqrt{\dfrac{269}{29^2 - 16 \cdot 13 \times 6n}} = \sqrt{\dfrac{269}{633 \times 6n}}$

$= \cdot 3002989$. Therefore $16x$ and $13x$ become $4 \cdot 8047824$ and $3 \cdot 9038857$ for the diameters of the hole.

The greater diameter drawn into 4 and 3 give $19 \cdot 2191296$ and $14 \cdot 4143472$ for the diameter at the middle and ends of the nave; and consequently its solidity including the hole will be

$\overline{14 \cdot 4143472^2 + 2 \cdot 19 \cdot 2191296^2} \times \dfrac{18n}{3} = 4460 \cdot 386$; from which taking 269 the content of the hole, there remains $4191 \cdot 386$ for the quantity of the solid.

Also, by the nature of the ellipse (see the last fig.) CB^2 : $CG^2 :: CD^2 - BH^2 : CD^2 - GI^2$; and hence $2GI =$ $2\sqrt{\dfrac{CB^2 \cdot CD^2 + CG^2 \cdot BH^2 - CG^2 \cdot CD^2}{CB^2}} = 17 \cdot 8745048$ (CB being 9 and $CG = 5$ by the question); which multiplied by $3 \cdot 74159$ &c. we have $56 \cdot 15441$ for the circumference of the hoop.

equation $a = 3.903886$ th. leſſer baſe of the cone's fruſtum, and $\frac{ca}{b} = 4.804782$ the greater baſe's diameter; whence the

greateſt thickneſs of the nave is — — 19.219128
Each end — — — — 14.414346
The ſolidity of the fruſt. the cavity ſubt. 4191.408136
The diameter 4 inches from the end — 17.874505
Circumference — — — — 56.154402

The lot for the prize fell to *Philomathematrea.*

Of the Eclipſes in 1720.

There can happen but two eclipſes this year, and both of the ſun, but inviſible to the inhabitants of our Britiſh iſlands. One of them is before the ſun's apogæon, and the other after; ſo that the earth's ſhadow, and her atmoſphere, are uncapable of eclipſing the moon.

1. Sun eclipſed the 28th of january, near 11 in the forenoon, at which time the moon's latitude is ſo much ſouth, that the ſhadow will be depreſs'd too far to be ſeen by us.

2. Sun eclipſed the 23d of july, about 3 o'clock in the morning, but ends ere the ſun is riſen.

The total eclipſe of the moon the 29th of auguſt, 1718, I obſerved near Chateſworth, in Derbyſhire: the beginning of total darkneſs 53 min. paſt 6, the end of total darkneſs 45 min. after 8 o'clock, the full end of the eclipſe 48 min. after 9 at night.

Mr. *John Child*, at Kingſthorpe, near Northampton, in Latitude 52¾, obſerved the end of the eclipſe 9 h. 50 min.

Adraſtea, of Wirkſworth, in Derbyſhire, ſent me the calculation of the moon's eclipſe on the 18th of auguſt, 1719, perform'd by her own hand from the Caroline Tables; and altho' the eclipſe will be over before this diary is publiſhed, yet I ought to acknowledge the favour by committing the reſult of her calculations to the preſs.

	h.	′	″
The equal time of the greateſt obſcuration —	8	29	6
Equation of time ſubtract — — —		14	3
Remains the apparent time of the greateſt obſ.	8	15	3
Time of half duration ſubtract — — —		58	0
Remains the beginning of the eclipſe, evening	7	17	3
Semi-durat. add, gives the end of the eclipſe	9	13	3

Duration 1 ho. 56 min. digits eclipſed 3 d. 13 m.

Sinc

Since there is no visible eclipse this year, 1720, I shall here insert one of the moon, which happens in the ensuing year 1721, the 22d of december.

Just as I received it in manuscript from the same ingenious gentlewoman.

	d.	h.	m.	s.
The mean ☌ 22d december, 1721 — —	22	4	7	2
Difference from the ☌ parts — — —			45	52
Hourly motion of ☉ 2′ 33″ of ☽ 30′ 7″ dif.			27	34
Interval of mean and true ☌ sub. — —		1	33	18
The middle time of the ☌ — — —	22	2	33	42
Anomaly ☉ 6. 4. 15. 58. Anomaly ☽ —	11	19	27	0
☉'s place in ♑ . — — —	9	11	46	47
The moon's place in the ecliptic ♋ —	3	11	57	17
The place of dragon's head sub. — —	3	11	36	36
Arguments of latitude — — —			20	41
Reduction 5″ subtr. latitude of ☽ north —			1	44
Difference of hourly motions — —			27	36
Reduction contrary to the title add — —				11
Correct equal time in the ecliptic — —		2	33	53
Reduct. subt. greatest obscuration — —	22	2	33	31
Equation of time add — — —			3	38
Apparent time at London — — —		2	37	9
Difference of meridians subtract — —			6	
Apparent time at Wirksworth — —	22	2	31	9
Half duration — — — —		1	51	40
Beginning of the eclipse — — —		XII	39	29
End of the eclipse, evening — — —		IIII	22	49
Lat. ☽ at begin. 5′ 14″ sou. at the end nor.			6	33

This eclipse is total to the eastern inhabitants, but with us will not, because the ☽ rises not till the greatest part is expir'd; she appearing then about 6 digits darkened.

——Et fœcunda facit pectora laudis amor.
Vivitur ingenio; cætera mortis erunt.

P.S. Near Beighton, in Derbyshire, the 18th of august, 1719, I observed the moon's eclipse about 3 digits 18 min. darkened on her north limb at 26 minutes after 8, and the end at 20 min. after 9, being in duration something longer than the former calculation of mine.

Paradoxes to be answered next year.

1. There is a certain people in South America, who are properly furnish'd with only one of the five senses, viz. that of touching; and yet they can both hear and see, taste and smell, and that as nicely as we Europeans, who have all the five.

2. There is a certain place on the continent of Europe, where if several of the ablest astronomers the world now affords should nicely observe all the celestial bodies, and that at the same instant of time; yet the planetary phases, and their various aspects, would be really different to each of them.

3. There is a certain European island, the northermost part whereof doth frequently alter both its longitude and latitude.

4. There are two distant places of the earth lying under the equinoctial line, whose difference of longitude is compleatly 86 degrees and a half; and yet the true distance between these two places is not full 86 Italian miles.

Paradox 5, by Mr. C. Mason.

Leander to his Hero writ; and she
As oft writ back to shew her constancy:
When with them both the post three times had been;
They had no more than each a letter seen.

New Questions.

I. Question 75, by Mr. Tho. Dodd, Apr. 30, 1720.

At Michaelmas last, seventeen hundred nineteen,
My writings will shew, which are yet to be seen,
That to me were three hundred and twenty pounds due:
And half of that sum, besides forty-two,
Just five years after that I might demand;
But would fain have the whole somewhat sooner in hand.
I agree to rebate for the latter sum too,   * Simp. interest.
At the same rate of interest * our commons allow;
And I likewise expect some use will accrue,
For my sixteen score pounds, that last year were due.
Now to know on what day, I should be very fond,
To receive my five hundred and twenty-two pound.
II. Question

II. *Question* 76, *by Mr.* W Crabb.

If the fide of the face of each body platonic
Be twenty-nine inches, as you may project;
Then good Mr. Gauger, now try to unfold,
How many wine gallons each body will hold?
And to this our author the fame do impart,
And you'll oblige thofe that are lovers of art.

III. *Question* 77, *by Mr.* W. Deare.

Upon a friend's requeft, the other day,
A field triangular I did furvey;
The longeft fide, fave one, is juft 8 chains,
Six fcore degrees the angle blunt contains,
From which a perpendicular let fall
Upon the bafe, th' alternate * fegment fhall
Be $5\frac{12}{13}$ chains. Explore, I pray,
The other fegment, fide, and area?
        * *Segment or bafe next the fide required.*

IV. *Question* 78, *by Mr.* G. Hare.

Suppofe a plane in latitude fifty-three
Decline, and fhou'd recline, as here you fee,*
In what latitude fhall that plane become
An upright? and what declination
Shall this plane have, in that latitude?
And what angle fhall the meridian
In fuch a plane make with the horizon.
Style's height and diftance alfo let me fee,
What will fubftile from meridian be?
As alfo fhow, where the hour lines will fall
By calculation arithmetical?

        * *North-weft decl.* 43° 15', *reclin.* 49° 20''.

V. *Question* 79, *by Mr.* John Afhton.

As I with fome ladies was drinking of tea,
The weather was pleafant, and the firft day of May;
I happen'd t' applaud their brifk genius and wit,
Yet thought mathematics for them not fo fit;
But nettl'd at this was a learned brifk lafs,
And fun fhining plain on a fpecular glafs,
To th' top o'th' eaft corner of the room came the rays;
Let's fee by your learning? She anfwering prays;

This glafs is i'th' middle o'th' wall I do find,
Horizontally plac'd, which ftands to th' fouth wind.
The area o'th' end of the room I here fhow, [80 foot]
The whole room's dimenfions from hence I would know,
With the time of the day? But I'll tell you below,
That the height of the fun is exactly the fame,
As azimuth, I truly do find by the beam.
  A difh of the beft fhall then be your due;
But, ladies, the point I refer unto you,
Since your fex propos'd it, pray tell it me too.

VI. *Queftion* 80, *by* S. T.

A vacuum in the earthly globe fuppofe,
Extended to the fuperficies clofe:
Then grant that we above a river have
Of conftant courfe, and fwift unalter'd wave:
Twelve yards its breadth; but fix its depth do fhow;
A thoufand yards an hour it runs; and fo
It falls into the vacuum below.
Its time to fill it up, pray let me know?

VII. *Queftion* 81, *by* Mr. J. Jennings.

A houfe (fuppofe) was bought and alfo fold,
Whofe coft exceeds its gain, as I am told,
One hundred and fixty pounds in gold.
Their fquares together added, will amount
Unto the fum * annex'd. Pray, ladies, count   * 70600
What is the coft, and alfo what the gains:
Which if you do, I'll thank you for your pains.

VIII. *Queftion* 82, *by* Mr. William Doidge.

As I was walking on a fummer's day,
Thinking to drive the tedious hours away;
I faw a cone, whofe vertex from the ground,
Upon the flant, juft fixty feet I found.
The true contents of its folidity,
Are thirty thoufand feet and fixty-three;
The perpendicular height o'th' cone to find,
All means I've us'd; 'twill fure diftract my mind.
Affiftance, ladies, I moft humbly crave:
I pray, from ruin do your fervant fave.

IX. *Queſtion* 83, *by Mr.* J. Plomley *or* N. M.

From the high crofs in Briſtol two men once ſet out,
Reſolving to travel the whole world about:
The one direct eaſterly ſteering his way;
The other went north, as ſome people do ſay:
The firſt travell'd 7 miles $\frac{455}{1113}$ every day,
The other $11\frac{143}{167}$: But now I you pray,
How many times round the world muſt they go?
And how many * miles will each travel alſo?
And how many days muſt they be to obtain,
To meet at the crofs aforeſaid again?

   * *Reckoning* 360 *degrees, each* 60 *Engliſh miles vulgar computation.*

The Prize Queſtion ; the anſwerer may by lot win 10 *of
theſe diaries.*

With heads full of ale, joke, pun, and banter,
Two young tyros, who'd talk'd much of Gunter,
Euclid, and Barrow, fell to ſquabble of arts,
Being confident each of his own brighter parts,
I'th' Cyclopædia agreed as a proof,
To find the contents of an old kneading-trough;
Whoſe bottom was turn'd up on this occaſion,
To ſerve as a table, in their potation.
The guinea lugg'd out, a wager was laid,
And into the hands of their landlady paid.
Both fell to ſcrawling, each ſure of the matter;
But diſagreeing, choſe me arbitrator:
And with the dimenſions they to me came poſt;
But when they came in, in good ſooth they were loſt:
No matter, ſays one, we ſhall do well enough,
I remember, five-thirds o'th' breadth of the trough
Reach'd croſs the bottom as a diagonal line,
From the bottom's edge to the upper edge or brim.
Alſo the ſides, ends, and bottom are all
One breadth.——Says t'other, I have not forgotten.
11·75 feet is the perimeter at bottom,
And the area is juſt one half of that ſum
In ſquare feet and parts (as ſure as a gun).
Now, ſir, we requeſt you, from this number given,
To find that part's contents o'th' trough, if ſet even
Or level—to the diagonal line?
And how many gallons it will hold in wine?
And alſo the whole trough's vacuity
In inches : ——pray tell me how many they be?

The

1721.

The Author's Preface.

ALthough learning, and the mathematical fciences, have never wanted the defence of many excellent pens, and met with the higheft applaufe, thro' all ages, and (moft) countries in the known world; yet we often find men of fo bafe a fpirit, that either from the height of ignorance, or envious fpleen, they ftill dare to defpife 'em.

Ars nullum habet inimicum nifi ignorantem.

But moft generally their envy is levell'd at the female fex, for (fay they) learning makes a woman proud and impertinent; 'tis not the bufinefs of their fex: the management of their families, and religion, ought only to be their ftudy. But for my part, I cannot fee that the fearch after truth and reafon, the improvement of the mind, and duly rectifying the judgments, by thofe rules, and unerring opinions, of the wifeft men, fhould any more conduce to the bringing a woman into errors, than the fearch after virtue fhould be thought the only way to teach us vice. Nor can I conceive, that a woman who does mathematically demonftrate, *that the whole is equal to all its parts*, or 2 and 2 make 4, is lefs capable of managing her houfhold, governing her fervants, and giving her children due education.

Nor will fhe be the lefs a chriftian, for underftanding the fyftem of the univerfe; but on the contrary, admire that infinite wifdom of the Creator, who alone could make and govern things fo vaftly furpaffing our comprehenfion. On the other hand, it might as well be faid, he who underftands Horace and Virgil, is incapable to manage his eftate; or becaufe he underftands geometry and mathematics, he is unfit to plow, fow, or buy and fell the products of the fame. Whoever fhould affert thefe things, muft by all the world be thought guilty of the greateft madnefs or ftupidity. Ignorance never fets a value on any perfon, but has always been found a conftant attendant on felf-conceit and impudence; when learning is the way to modefty and good manners. Ignorance is for ever incapable of knowing and doing right; but knowledge like a diamond polifhed, more illuftrioufly fhines.

Stationers' Hall, London,
the 4th of auguft, 1720.

Paradoxe

— ···

Paradoxes answered.

First Paradox answer'd.

All the senses are properly by the touch; in seeing, the object touches the retina; hearing, the sound touches the drum of the ear; smelling, the effluvias touch the senforium; tasting, the palate, &c.

Second Paradox answer'd.

Neither at the center, nor any part of the earth, can any one observe all the celestial bodies at one and the same instant of time.

3*d.* This is meant a floating island, removing by the sea.

4*th.* The places are not suppos'd on the surface of the earth, but nearer to the center, where the longitudes all coincide.

The 5th par. means, with both, not each 3 times; the post first took Leander's letter, 2d Hero's answer, 3d brought it to Leander.

Solutions to the questions.

* I. *The* 75th *Question answer'd.*

The author's solution is, the payment must be April 30, 1721.

II. *The*

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* I. Q U E S T I O N 75 *solved.*

The sum 320 *l.* being due the 29th of September, and the other sum 202 *l.* due just 5 years afterwards; the meaning of the question is to find such a day between these two times, as that the whole sum 522 *l.* being then received, neither the receiver nor deliverer may suffer any loss; in which case it is evident that the interest of the 320 *l.* for the time it is kept beyond the time when it was due, must be equal to the discount of the 202 *l.* for the time it is received *before* it is due.

Hence

* II. *The 76th Question answer'd by Mr.* Dodd.

The wine that each body platonic will hold,
In the numbers annex'd, is demonstrably told.
The dodecaedron, so much does contain,　-809·072 *W. gall.*
The icosaedron will hold, it is plain;　　230·343
Hexaedron's content, in this number I shew,　105·58
Thus much the octaedron affords unto you;　49·77
Divide the last sum exactly by 4,
Tetraedron that quantity holds, and no more.　12·442

III. *The*

Hence then, denoting the time for the discount by x, and con-
sequently the time for the interest, or till the whole must be paid,
by $s - x$; by the rules for interest and discount, $320 \times \dfrac{5}{100}$
$\times \overline{s - x} = 16 \times \overline{s - x}$ will be the interest of 320 for the time
$s - x$, and $100 + sx : sx :: 202 : \dfrac{202 x}{20 + x} =$ the discount of
202 for the time x, the rate of interest being 5 per cent. Conse-
quently $16 \times \overline{s - x} = \dfrac{202 x}{20 + x}$; hence $x^2 + 27\frac{1}{2}x = 100$, and
$x = 3\cdot239888$. Wherefore $s - x = 1\cdot76$ years nearly $= 1$ yr.
277 days; which being added to Sept. 29, we have the 3d of July
1721 for the day of payment.

* II. QUESTION 76 *solved.*

By page 404 &c. of my Mensuration, it is found that the solidi-
ties of the five regular bodies, the side of each face being **1**, will
be thus:

Tetraedron　＝　0·11785113
Hexaedron　＝　1·00000000
Octaedron　＝　0·47140452
Dodecaedron＝　7·66311896
Icosaedron　＝　2·18169499.

Then, since similar solids are as the cubes of their like sides,
each of these numbers being multiplied by 24389 the cube of 29,
the products will be the contents of the bodies in inches; and if
these contents be divided by 231, the inches in a wine gallon, there
will result the several numbers of gallons as in the original solution.

* III. *The 77th Question answer'd by* Mr. Crabb, Mr. Allen, Mr. Failes, Mr. Chorley, Mr. Finch, Mr. Gurney, Mr. Dodd, *and* Mr. White.

24·2787 chains = 2 ac. 1 ro. 28 per.

IV. *Question*

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* III. Q U E S T I O N 77 *solved.*

In this question are given the vertical angle, one side, and the alternate segment of the base; viz. the angle $ABC = 120$ degrees, $BC = 8$ chains, and $AP = 5\frac{14}{17}$ chains.

Put $a = BC = 8$, $b = AP = 5\frac{14}{17}$, $s = \frac{1}{2}\sqrt{3}$ sine of the angle ABC or 120°, and $z = PC$. Then, by right-angled tri-angles, $BP = \sqrt{a^2 - z^2}$, and $AB = \sqrt{b^2 + a^2 - z^2}$; $AB \times BC \times$ sine $\angle B =$ twice the area $= BP \times AC$, that is, $as\sqrt{b^2 + a^2 - z^2} = \overline{b+z}.\sqrt{a^2 - z^2}$; and this, by squaring both sides, and writing the numbers instead of the letters, becomes $48 \times \overline{16745 - 169z^2} = \overline{77 + 13z}|^2 \times \overline{64 - z^2}$, which will be an equation of the 4th order; and by expanding it out, the root z may be found by converging series. But the root will be much easier found by the method of Trial and-Error, from the equation as it here stands; and by this method z will come out 7·077 or $7\frac{1}{17}$. Hence the base AC is 13, and the area 24·248 square chains.
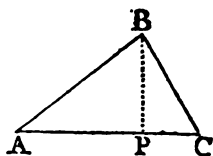
Scholium.

This problem is the same as to divide a given angle into two parts such, that the tangent of the one may be to the secant of the other, in a given ratio.

* IV. *The 78th Question answer'd by* Mr. Hawney, Mr. Failes, Mr. White, Mr. Williams, *and* Mr. Finch.

h.	equin.		h. dift.	
	o	'	o	'
VIII	140	9	143	12
IX	125	9	128	20
X	110	9	112	24
XI	95	9	84	18
XII	80	9	78	56
I	65	9	62	33
II	50	9	46	53
III	35	9	32	7
IIII	20	9	18	8
V		5	9	4	36
	Sub—		Stile E.	
VI	9	51	8	48
VII	24	51	22	26
VIII	39	51	36	38

|	o	'
The dial's new latitude south	4	58
New declination weft —	26	31
Dift. of fubftile and merid.	78	56
The ftile's height — —	63	3
Diftance of merid. and hor.	54	29
Plane's differen. longit. —	80	9

V. *Question*

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† IV. QUESTION 78 *folved*.

The meaning of this queftion is, that fuppofing in the latitude of 53° (north) a plane to face the north-weft quarter, making an angle of 43° 15′ with the weft line, and reclining backward towards the fouth-eaft quarter 49° 20′, if this plane be moved along the fame meridian continually parallel to its firft fituation, till it be-comes an upright plane; to find then the proper requifites for a dial to be defcribed on it.

Conftruction.

Let $ELQN$ be the horizon and Z the ze-nith of the place in lat. 53°, P the pole, LZN the pofition of the plane making the angle EZL = 43° 15′, EZQ be-ing the prime vertical, $PZDA$ the meridian, and EDQ the equi-noctial. Perpendicular to LN draw ZB equal to 49° 20′ the reclination, and draw the great circle $LABN$, which will be the plane of the dial, A being the new place.
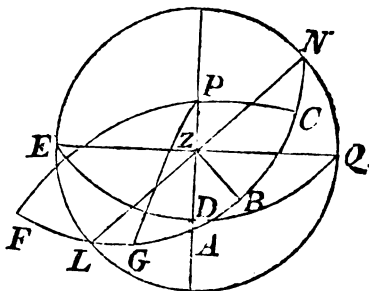
V. *Queſtion* 79. *anſwer'd.*

This queſtion was imperfectly propos'd, no lat. being fixed, ſo anſwers may vary for different places. The propoſer, in

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place required; alſo draw the great circle or meridian *C P F* perpendicular to *N A L F*.

Then *D A* will be equal to the new latitude ſouth; in which the plane will be upright, the angle *Z A B* the co-declination, *A F* the the diſtance of the ſubſtile from the meridian, *P C* the ſtile's height, *A L* the diſtance of the meridian and horizon, and the angle *A P F* the plane's difference of longitude.

Calculation.

1. In the right-angled triangle *A B Z*, given *Z B* the reclination $= 49° 20'$, and $\angle A Z B$ the declination $= 43° 15'$. Then

As Coſ. $\angle A Z B = 43° 15'$: Radius :: Tang. $Z B = 49° 20'$: Tang. $A Z = 57° 58'$; from which taking $Z D = 53°$, there remains $D A = 4° 58'$ the new latitude.

As Radius : Sine $\angle A Z B$ :: Coſ. $Z B$: Coſ. $\angle A = 63° 29'$, whoſe complement $26° 31'$ is the new declination.

As Radius : Sine $Z B$ :: Tang. $A Z B$: Tang. $A B = 35° 31'$ the complement of $54° 29'$ the diſt. of merid. and horiz.

2. In the right angled triangle *A F P*, are given $A P = 94° 58'$, and $\angle A = (180° - 63° 29' =) 116° 31'$. Then

As Radius : Coſ. $\angle A$ :: Tang. $A P$: Tang. $A F = 78° 59'$ the diſtance of the ſubſtile from the merid.

As Radius : S. $A P$ :: S. $\angle A$: S. $F P = 116° 57'$, whoſe ſupplement $63° 3'$ is the ſtile's height.

As Radius : Coſ. $A P$ :: Tang. $\angle A$: Cotang. $\angle P = 80° 9'$ the plane's diff. of longitude.

Now this $80° 9'$, or plane's difference of longitude, ſhews that the diſtance, on the equinoctial *D E*, of the hour line *P A* of 12, is $80° 9'$ from the ſubſtile *P F*; and which is therefore ſet oppoſite to it in the table to the original ſolution. The equinoctial diſtances in the ſame column of the table, belonging to the other hours, are found by the continual addition and ſubtraction of $15°$. And the ſeveral diſtances, on the plane of the dial, in the other column of the table, againſt the equinoctial diſtances, are all found by this proportion, As Radius : S. $63° 3'$ the ſtile's height :: Tang. of each equinoctial diſtance : Tang. of the correſponding diſtance on the plane of the dial. For if *P G* be any hour circle; then, in the right-angled triangle *P F G*, As Radius : S. *P F* :: Tang. $\angle P$: Tang. oppoſite ſide *F G*.

Note. In the table to the original ſolution, for the diſtance on the plane againſt the hour XI, the author has ſet $84° 18'$ inſtead of its ſupplement; or rather indeed ſhould be $95° 46'$ the ſup. $84° 14'$ as appears by calculation.

in latitude 53 28, as alſo Mr. *Crabb*, Mr. *Allen*, Mr. *Finch*, Mr. *Wall*, Mrs. *Dod*, and ſeveral others, anſwer.

Time of the day 2 ho. 6 min. altit. and azimuth 48 20, length of the oppoſite ſide of the room 7·29216 foot, height 10·97, breadth of end walls 3·245, May 1, 1719, London.*

VI. *The*

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* V. QUESTION 79 ſolved.

With the above original anſwer, ſuppoſing the latitude to be 51° 32' that of London. Then, in the annexed figure, if *P* be the pole, *Z* the zenith, and ☉ the ſun; we have given $PZ = 38° 28'$ the co-latitude, $P☉ = 72° 6'$ the co-declination for May 1 old ſtile or May 12 new ſtile, and the ſupplement of the angle $Z =$ the complement of $Z☉$; to find the hour angle *P*.
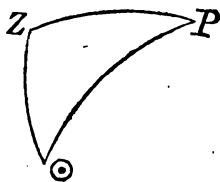
Put *a* and *b* = the ſine and coſine of PZ, *c* = the coſine of $P☉$, and *x* and $\sqrt{1-xx}$ = the ſine and coſine of $Z☉$, or coſine and ſine of the $\angle Z$.

Then, by common trigonometry, $axx + b\sqrt{1-xx} = c$. Hence by completing the ſquare and extracting the roots, we obtain $x = ·6937742 =$ the coſine of 46° 4" the altitude and azimuth. Alſo,

as s. $P☉$: s. Z :: s. $Z☉$: s. $P = \frac{x\sqrt{1-xx}}{d}$ (putting $d =$ s. $P☉$) $= ·5250344 =$ the ſine of 31° 40'; which, at 15° to the hour, anſwers to 2 h. 6⅔ min. afternoon.

Again, if *ABCD* repreſent the floor of the room, *S* the ſpeculum in the middle of the ſouth ſide *DC*, and *B* the eaſt corner, and *SB* be drawn; then will the angle *B* be $= 46° 4' =$ the azimuth from the ſouth; alſo the triangle formed by *SB*, the height of the room, and the reflected ray, will be ſimilar to the triangle *SBC*, becauſe the altitude is equal to the azimuth. Wherefore, if *s* and *c* denote the ſine and coſine of 46° 4' the azimuth, or the ſines of the acute angles of the ſaid two triangles, and *z* the line *SB*; then will *SC* be $= sz$, $CB = cz$, and

$c : s :: z : \frac{sz}{c} =$ the height of the room. Now, if the area of

S 2   the
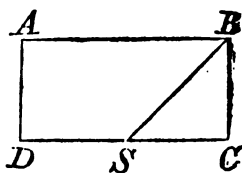
* **VI.** *The* 80*th Queſtion anſwer'd.*

In regard the diameter of the earth is variouſly computed; the anſwers to this muſt differ from one another accordingly: Mr. *Grabb* anſwers 1469,982,847,541 years, according to 60 miles a degree.

† **VII.** *The* 81*ſt Queſtion anſwer'd.*

250 pound coſt, and 90 gain.

                                      VIII. *The*

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the end BC be 80, then $\frac{sz}{c} \times cz = sz^2 = 80 = a$; hence $z = \sqrt{\frac{a}{s}} = 10\cdot54$, and then the breadth $BC = 7\cdot3123$, the length $DC = 15\cdot1804$, and the height $= 10\cdot94$.

But if the area of the ſide DC be 80; then $\frac{sz}{c} \times 2sz = \frac{2s^2z^2}{c} = a$; hence $z = \frac{\sqrt{\frac{1}{2}ac}}{s}$, and then the breadth $= 5\cdot075$, the length $= 10\cdot536$, and height $= 7\cdot5931$.

* VI. QUESTION 80.

By the queſtion, $6 \times 12 \times 1000 = 72000$ cubic yards of water run in an hour, or $72000 \times 24 \times 365\frac{1}{4} = 631152000$ cubic yards in a year. Now if the circumference of the earth be 21600 nautical miles, then $\dfrac{21600^3}{\overline{3\cdot14159\ \&c.}|^2 \times 6}$ nautical miles or

$\dfrac{21600^3 \times 1760^3 \times 7^3}{\overline{3\cdot14159\ \&c.}|^2 \times 64}$ cubic yards will be the content of the earth; which being divided by 631152000, the quotient is 2334289000000 for the number of years required.

So that the firſt figure in the original anſwer ſeems to be falſely printed 1 for 2.

† VII. QUESTION 81. *ſolved.*

In this queſtion, are given the difference of two numbers, and the ſum of their ſquares, to find the numbers.

Put $d = 160$ the difference, $s = 70600$ the ſum of the ſquares, and $x =$ the coſt. Then $x - d =$ the gain, and $x^2 + \overline{x - a}|^2 = 2x^2 - 2dx + d^2 = s$. Hence $x = \dfrac{d + \sqrt{2s - d^2}}{2} = 250$ the coſt, and $x - d = 90$ the gain required.

* VIII. *The 82d Queſtion anſwer'd.*

The perpendicular height 55·5234 feet.

† IX. *The 83d Queſtion anſwer'd.*

The firſt man travels 7 times round the globe, 151200 miles; the ſecond, 11 times, or 237600 miles, and in 21535 days, or 59 years,

The

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* VIII. QUESTION 82.

Put $a =$ 60 the ſide, 30063 the content, and $z =$ the perpendicular height Then the radius of the baſe will be $\sqrt{aa - zz}$, the area of the baſe $= \overline{aa - zz} \times 3\cdot1416$, and the content $= \dfrac{a^2 z - z^3}{3}$ $\times 3\cdot1416 = 30063$; hence $z = 55\cdot52446 =$ the perpendicular required.

† IX. QUESTION 83:

It is evident that the number of times round each perſon travels, before they meet, will be directly as his rate of travelling. The queſtion then only requires to be found the leaſt two whole numbers that ſhall be in a given ratio; and ſuch two numbers it· is· clear muſt be the leaſt integer terms of the ſaid ratio. Now the given terms of the ratio are $11\frac{143}{707}$ and $7\frac{455}{317}$ or $7\frac{26}{707}$; and· by dividing the former of theſe terms by 11, and the latter by 7, the quotient of each is $1\frac{13}{707}$; therefore the leaſt terms of the ratio. are 7 and 11, and which of conſequence give the number of times each travels round.

The Prize Question answer'd by Mr. J. Jope, *jun.*

Length at top	5'591	The whole vacuity	18563'74
Breadth —	2'272	Vac. even with diag.	12156'85
Length at bottom	4'5969	Remaining part —	6406'89
Breadth —	1'2780	Liquor, 27'735 wine gallons.	
Depth —	1'1774		
Diagonal —	2'1300		

The prize of 10 *diaries was won by* Mr. Rich. Burnell *of* Dewsbury, *in Yorkshire.*

Of

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* P R I Z E Q U E S T I O N.

Let *ABCDEHGF* be the trough, its depth *DI*, being a perpendicular from top to the bottom. Then by comparing the words of the question with this figure, the conditions will appear to be thus : Of the rectangle *EFGH* the perimeter is 11'75, and the area $= 5'875$; $HE = EK = \frac{1}{4}$ of *HK* the nearest distance of *GH* from *AD*; and *HE*, *EK* are also each $=$ the distance between *CD* and *HE*, in consequence of which $EL = LI$ will be equal to the half difference of both the lengths and breadths at the top and bottom, and therefore the solid is a prismoid, and not the frustum of a pyramid : And it is required to find the whole content, as well as that of the wedge *ADEHGF*.
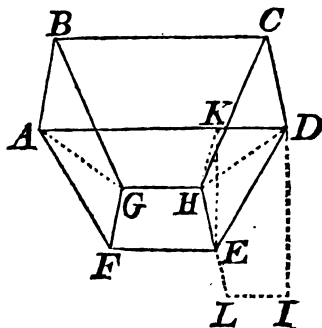
Now if *x* and *y* denote the length and breadth of the bottom, then $2x + 2y = 11'75$, and $xy = 5'875 = x + y$. From these equations we find $x = 4'597 = EF$, and $y = 1'278 = EH = EK$. And therefore $HK = \frac{1}{2}EH = 2'13$. Then in the obtuse isosceles triangle *HEK*, by Eucl. II. 12, $EL = LI = \dfrac{KH^2 - KE^2 - EH^2}{2EH}$

$= \dfrac{2\frac{1}{2}HE^2 - 2HE^2}{2HE} = \frac{7}{18}HE = '497 =$ half the difference between the lengths and breadths ; and whose double therefore being added to the length and breadth at bottom, we have $5'591 = AD$, and $2'272 = DC$, the length and breadth at top. Also,

by

Of the Eclipses in 1721.

In this year three times the fun and moon are within the bounds of eclipfing, at the conjunction; and three times the fun and moon in oppofition, the earth will interpofe and eclipfe the moon.

1. Moon eclipfed January 2, the greateft obfcuration at Coventry 16 min. after 3 in the afternoon, but the eclipfe ends as the moon rifes, fo can't be feen.

2. Sun eclipfed Monday the 16th of January, at 8 o'clock at night, after fun-fet, invifible.

3. Moon eclipfed Wednefday the 28th of June, 40 min. paft 8 in the morning, the moon being then fet, invifible.*

4. The fourth is a vifible eclipfe of the fun on Thurfday the 13th of July, exactly at 8 in the the morning.

	London h.		Coventry		London by Leadbetter		Coventry by Chattock	
The beginning	VII	22	7	16	7	1	7	21
Vifible conjunct.	VIII	7	8	1	7	45	8	2
Greateft obfcur.	VIII	1	7	55	7	40	7	56
The end	VIII	36	8	30	7	21	8	32
Whole duration	I	13	1	13½	1	20	1	11
Digits eclipfed	I	15	1	15	1	35	1	13

5. Sun

by right-angled triangles, $DI = KL = \sqrt{KE^2 - EL^2} = \sqrt{HE^2 - \frac{7^2 HE^2}{18^2}} = \frac{5 HE \sqrt{11}}{18} = 1.1774 =$ the depth of the veffel.

Then, by page 161 Menfuration, the content of the wedge $ADEHGF$ is $\frac{2EF + AD}{6} \times EH \times DI = 3.707873$ cubic feet or $= 6407.104$ inches $= 27.728$ wine gallons. And the content of the wedge $ABCDHG = \frac{2AD + GH}{6} \times DC \times DI = 7.034942$ cubic feet $= 12156.37$ inches. Alfo the fum of thefe two is 10.742815 feet $= 18563.57$ inches.

* The 3d eclipfe on the 28th of June, was obferved by Mr. *Robie* at *Harvard* College in *New England*.

h. m. s.
2 10 0 A thin penumbra.
2 12 0 The fhadow is plainly entered.
3 18 30 Moon wholly covered.

5. Sun eclipfed December 8, at 1 in the morning, invifible.

6. Moon eclipfed Friday Dec. 22, total, and part vif. 2 ev.

The time at Wirkfworth by Adraftea's calculation.		Coventry by Chattock		London by Leadbetter	
	h. m.				
The begin. evening	XII 39	0	56	0	32
Begin. of total darknefs	I 37	1	39	1	38
The middle —	II 33	2	30	2	27
End of total darknefs	III 18	3	20	3	16
The end ———	IIII 22	4	24	4	21
Whole duration —	3 43	3	48	3	49
Digits eclipfed —	20 48	20	39	20	17
☽'s lat. at begin. fouth	5 10	2	50		
At the end north afc.	6 30	7	0	E. M.	

The moon will not rife till near 4 o'clock, and the eclipfe near done.

New Paradoxes.

1. There is a certain place in the ifland of Great Britain, where the ftars are vifible at any time of the day, if the horizon be not o'ercaft with clouds.

2. There is a remarkable river on the continent of Europe, over which there is a bridge of fuch a breadth, that above three thoufand men abreaft may pafs along the fame, and that without crowding one another in the leaft.

3. There is a certain ifland in the vaft Atlantic ocean, which being defcry'd by a fhip at fea, and bearing due eaft of the faid fhip, at twelve leagues per eftimation; the trueft courfe for hitting of the faid ifland, is to fteer fix leagues due eaft, and juft as many due weft.

4. A Paradox by Mr. J. Lumley.

The day that I was born, my father he
Laid by five pounds, and faid it was for me:
And when e'er my birth-day came, he never fail'd
To add five pounds (his love fo much prevail'd):
At twenty-four, and upon my birth-day,
I wedded was, my portion he would pay:
Juft thirty-five pounds; (I full twenty-four)
How comes it then my portion was no more?

New Questions.

I. Question 84, by Mr. Sam. Dicker.

Within Megora's city, thro' the wood,
Call'd Jupiter's, t'th' caftle Caria, ftood
Two fmall fquare temples; to Nyctelius Bacchus
The one, the other t' Apoftrophia Venus,
Were dedicated; and their pavements laid
With foot fquare ftones; but Venus' temple ftray'd,
Each fide thereof, exceeding Bacchus, lay
Full twelve foot farther; but thefe pavements gay
Contain two thoufand fix fcore ftones: Pray tell,
Each in its fep'rate length erected well.

II. Question 85, by Mr. Moyle.

'Twas in the pleafant month of May,
The leaves were green, and flowers gay;
The winds lay ftill, the air was clear,
Only one cloud there did appear;
Which I by obfervation found,
Twenty degrees above the ground.
In altitude bright Sol was then
Above the cloud degrees fifteen;
The fhadow of the cloud, I found,
Did from my ftation touch the ground,
In yards exact, as e'er cou'd be,
The fame you in the margin fee.   [2304 *yards*]
This being known, to me declare,
The cloud's height perpendicular.

III. Question 86, by Mr. Jof. Dogharty.

Three fhips fail'd from a certain port to fea,
To different ports, whofe latitudes agree;
Fifty-five leagues the firft fail'd, fouth his coaft.
Th' others to coafts unknown, 'tween fouth and weft;
Till each arriv'd at his true deftin'd poft,
When they afunder leagues fifty-feven were juft:
Angle * thirty-eight made. Whence they begun,   * *Degrees*
Pray tell me what the courfe, and diftance run?

IV. Question

IV. *Queſtion* 87, *by Mr.* T. Williams, *of Middleton-ſtoney.*

> A friend did·buy the other day,
> Some land, a new unheard-of way;
> I'th' latitude of fifty-two,
> And by the method here below.
> > 'Twas to be bounded by the ſhade
> > That, March the tenth, a tall tree made,
> > Betwixt the hours of eight and one;.
> > Therefore triangular when done.
> > The topmoſt ſhade the baſe muſt ſhow,
> > And by the bodies the ſides you'll know.
> > One angle will be at the tree,
> > In height one hundred feet and three.
> > Now, ſir, I've ſent to you, for fear
> > The ſun ſhould not that day appear;
> > Pray ſhew the lengths and area clear.

V. *Queſtion* 88, *by Mr.* Chriſ. Harris.

Suppoſe a polygon, of ſeven equal ſides, were incloſed round about with ſhillings, each being an inch in the diameter; the ſhillings that reach round, juſt pays the purchaſe of what is incloſ'd at this rate:

> The ſhillings which do for one acre pay,
> Are eleven times the number of acres: Pray
> What number of acres incloſed muſt be,
> And the price of each acre pray let us ſee?

VI. *Queſtion* 89, *by* Adraſtea, *who in it anſwers all the Enigmas in the laſt year's diary.*

> In ancient times, when Minos kept his ſeat,
> Of law and juſtice, in the iſle of Crete;
> Then curious arts in infant dreſs appear'd,
> And none of ſailcloth's mighty uſe had heard:

Mechanic ſkill, ſcarce *Muſhroom* height could run,	91
Which *Winter* froſt deſtroys, and *Summer* ſun.	90
Till Dædalus, accus'd of murder, came,	
Whoſe art affix'd a proverb to his name:	
A labyrinth he form'd, more intricate	
Than thoſe wherein Newcaſtle *Coals* they get;	2d *Lat.*
In which himſelf and ſon were both confin'd,	
When glorious *Reputation* fir'd his mind.	97
What hardſhips mortal men are born to feel,	
No *Coach* turns half ſo faſt as fortune's *wheel.*	1ſt *Lat.*
Diſcord began in Candy's court to reign,	94
An *injur'd* huſband can't forgive the queen;	

Nor thofe were privy to her guilty love,
But Dæd'lus' arts muſt Dædulus remove.
Some *Plumes* he got, drawn from the grey *Goofe* wing,　95
To make a curious prefent to the king.
Which pinion-wife, he fix'd unto his arms,
And fwiftly flew from the impending harms:
Leaving Pafipha to bemoan her crime,
Or with her *Thimble*, to beguile her time.　　　93
While he in Cuma, to Apollo rais'd
A fplendid temple, where the god was prais'd.
Had Icarus a fheet of *Pins* employ'd,　　　90
When Sol's refulgent rays with wax he try'd,
His fate fevere, perhaps had milder been,
And he once more, perhaps, his father feen.
But where do poets rove? His wings were fails,
Which Boreas' *Bellows* fill'd with fpeedy gales;　　92
And when immur'd, as a fufpicious gueſt,
Himfelf and others by their aid releas'd.
　Some malcontents, in number twenty-four,
　With fpecious promifes his aid implore:
　Tell him, the charges they'll with joy defray,
　Name but the fum, and they'll the money pay.
　My coſt, fays he, is all that I demand;
　Twenty-four pounds, paid down, when next we land:
　But as you different in your orders be,
　I'll have you to this method all agree;
　The captains each a certain fum fhall pay;
　The captains' mates, each half as much as they;
　The common failors, one-fourth part of that;
　Half a failor's fhare muſt be each boy's lot.
Now tell me, artifts, how many there were
Of every fort, and what was each one's fhare?
For Cretans, fam'd for treachery and deceit,
Deny'd their promife, and ne'er paid the debt:
So after-ages may their fums rehearfe,　　　、
Or fing their numbers in heroic *Verfe*;　　　*Prize.*

　　　VII. *Queftion* 90, by *Mr.* Deare.

　A dying knight, in riches who abounds,
Leaves an eftate worth fifty thoufand pounds:
This for two hopeful children he defigns,
And that they thus divide it, them enjoins;
The elder fon the greater fhare muſt take;
Which being fquar'd, the fquare thereof will make
A number equal to the younger's fhare,
When multiply'd into the pounds that are
In the eftate. Their portions each declare.
　　　　　　　　　　VIII. *Queftion*

VIII. *Question* 91, *by Mr.* C. Mason.

An elliptical acre of grass there is given,
Whose length to its breadth is as nine is to seven;
How long is the tether, and how brought to pass,
That a horse fed no more than an acre of grass?

The Prize Question for 1721. *The gardens of Alcinous,*
from the seventh book of Homer's Odysses, translated by
Mr. Pope.

Close to the gates, a spacious garden lies,
From storms defended, and inclement skies.
Four acres was th' allotted space of ground;
Fenc'd with a green inclosure all around.
Tall thriving trees confess'd the fruitful mold,
And red'ning apples ripen here to gold.
Here the blue fig with luscious juice o'erflows;
With deeper red the full pomegranate glows.
The branch here bends beneath the weighty pear;
And verdant olives flourish round the year.
The balmy spirit of the western gale
Eternal, breathes on fruits untaught to fail.
Each dropping pear, a following pear supplies;
On apples, apples; figs on figs arise:
The same mild season gives the blooms to blow,
The buds to harden, and the fruits to grow.
Here order'd vines, in equal ranks appear,
With all th' united labours of the year:
Some to unload the fertile branches run,
Some dry the black'ning clusters in the sun;
Others to tread the liquid harvest, join.
The groaning presses foam with floods of wine.
Here are the vines in early flow'r descry'd,
Here grapes discolour'd, on the sunny side,
And there in autumn's richest purple dy'd.
Beds of all various herbs, for ever green,
In beauteous order terminate the scene.
Two plenteous fountains the whole prospect crown'd,
This thro' the gardens leads its streams around,
Visits the plants, and waters all the ground;
While that in pipes, beneath the palace flows,
And thence its current to the town bestows:
To various use, their various streams they bring,
The people one, and one supplies the king.

The

The king's pipe delivers the water ten foot and an half (Englifh meafure) below the furface of the water in the fountain, by an inch and three quarters bore: His brewing, once a week, takes fifty hogfheads of water, (wine meafure) kitchen, landry, other offices, &c. five hogfheads a-day. The people have occafion for twenty hogfheads a-day; their cock, of two inches diameter, is below the fountain twenty-two foot. His majefty fo much delights in a morning walk to fee the waters undifturbed, that his orders are, that the cocks fhall but run once every day, and that in the evening; fo long only, as may fupply next day's confumption, and for fo much in his refervoir, as fupplies his brewing each week. Then if the velocity or motion of the water be equal to that of an heavy body, acquired in thefe defcents; and alfo, it be premifed, that heavy bodies accelerate as the fquares of their times, as fixteen foot the firft fecond it falls, &c. How long every day ought each pipe to run, to give the king and people their due quantity?

A Dissertation on Engines.

Amongst the many useful inventions, those engines that are mov'd by the wind, water, horses, &c. such as mills, water-works for towns, gins, and machines for draining of mines, are not the least valuable; tho' generally very inartificially perform'd, more especially the latter.

It were much to be wish'd, they who write on the mechanical part of the subject, would take some little pains to make themselves masters of the philosophical and mechanical laws of (motion or) nature; without which, it is morally impossible to proportion them so as to perform the desired end of such engines. We generally see, those who pretend to be engineers, have only guess'd, and the chance is, they sometimes succeed; else they have made them like others that have done pretty well. But he who has skill enough in geometry, to reduce the physico mechanical part to numbers, when the quantity of weight or motion is given, and the force design'd to move it, can bring forth all the proportions, in a numerical calculation, so as it may be almost impossible to err.

For was I to raise a certain number of hogsheads of water in an hour, by a water-wheel, I must first find the quantity and velocity of my aquæduct, design'd for to fall on my wheel, from which I may proportion the diameter of my wheel; and such pumps, suckers, forcers, chains, or buckets; as that the force on my wheel may be so far superior to the weight of the columns of water to be raised, as it may be capable, by a certain number of revolutions in the hour, to fit my purpose, with due regard to the friction of the engine.

The following table I calculated in 1717, for a particular sort of engine; wrought by the pressure of the atmosphere, on the vacuum of an exhausted receiver; which is easily done 16 or 20 times a minute: the atmosphere pressing with a weight near 15 pounds avoirdupois, on every square inch contain'd in the surface of the piston or sucker, when the mercury stands at 29½ inches (a medium) in the barometer. The ale gallon of 282 cubic inches weighs of pure water 10 pound 2 ounces avoirdupois. But to allow for frictions, and for a considerable velocity, each inch of the vacuum, experience tells us, will raise but about 8 pounds of water.

A

A Physico Mechanical Calculation of the Power of an Engine.

Diam. of the pump. Inches	Draws at a 6 foot stroke. Ale gall.	At 16 ft. in a min. draws per hour. Hogsh.	Gall.	The diameter of the cylinder. The depth to be drawn in yards. Inches.												
				15	20	25	30	35	40	45	50	60	70	80	90	100
4	3·20	48	51					9	10	11	11¼	12	13¼	14	15	16
4¼	4·04	60	60				10	11	11¾	12	13	14	15	16	17	18¼
5	5·02	66	61			10	11	11¾	13	13¾	14	15½	16¾	18¼	19¼	20¼
5½	6·26	94	30		10	11	12	13	14	15	15¼	17	19	20	21	22¼
6	7·22	110	1	9½	11	12	13	14	15½	16	17	19	20½	22	23	24¼
6½	8·46	128	54	10	12	13	14	15¼	16½	17	19	20	22	23	24¼	26¼
7	9·82	149	40	10¾	13	14	15¼	16¼	18¾	18	20½	22	24	25½	27	28¼
7¼	11·32	172	30	10½	13¾	15	16½	18	19	19	21¼	23½	25	27	28¼	30¼
7¾	12·02	182	13	12	14	15½	17¼	18¼	19¼	20	22	24½	26	28	29¼	31¼
8	12·82	195	22	12½	14½	16¼	18¼	19	20½	21¼	23	25	27	29	30½	32½
8½	14·52	221	15	13¼	16¼	17¼	19	20¼	21½	23	24	26¾	28½	31	32½	34¼
9	16·24	247	7	14	16¼	18	20	21¼	23	24¼	25	28	30¼	33	35	35¼
10	20·04	304	48	15¼	18	20	22	23¾	25½	27	28¼	31¼	33¾	36	38¼	40

The

1722.

The Author's Preface.

INtellectual complexions have no defire fo ftrong as that of knowledge; nor is any knowledge unto man more certain than the mathematical fciences : A ftudy both ufeful and applicable to almoft all the affairs of human life. For what bufinefs or difcourfe can we enter upon wherein quantity, time, or magnitude has not an immediate concern ? By thefe we ought to model our arguments, as we would defire they fhould be clear, intelligible, and bear the teft of the world: a thing I have obferv'd almoft generally neglected.

It has long been a maxim with me, *That any difcourfe, relation, or arguments, about quantity or meafure, which agrees not to numbers, is in itfelf evidently falfe.* And fince nothing can fo regulate our minds to think and fpeak demonftratively, as the mathematical fciences, it may fufficiently juftify my endeavours to introduce fome few of both fexes to the ftudy of them.

Providence has wifely defign'd, that the fciences and arts feverally have their votaries; and in what condition of life foever, each have their defires and objects fitted to them, whence fprings their content and happinefs in each ftate : but we generally obferve, above all others, how equal is the diftribution of wit, moft being content with their fhare ; though few with fortune. Amongft the moft knowing parts of mankind, knowledge is more highly preferable than riches and vaft poffeffions, by how much it diftinguifhes us above the brutes; which fortune only puts into a good pafture. If we are fallen in a middle ftate between too great a load of cares in the world, and the depreffion of poverty, we may with Agar be content: And whilft we ftrive to excel each other in arts and fciences, let not others out-ftrip us in content and a good life; it fhall then be fatisfaction enough for me, if I'm in fome meafure ferviceable to my country, in a ftudy not unpleafant to myfelf.

Pro captu lectoris habent fua fata libelli.

Griff, Juxta Covent. decimo nono Auguftij, 1721.

Introduction and Corrections.

It was a rule laid down by my predecessor, that whoever sent questions, enigmas, &c. should give the solutions with them, and this experience shews me is very requisite: for it may sometimes so happen, that an enigma may be doubtful, or admit of more solutions than one, which utterly destroys the design. And as it seems very difficult in mathematical questions, where terms of art are to be preserv'd, to write clear, intelligible, and in a smooth stile, confining one's self to the jingle of words; it may not be wonder'd at, that some questions have not been so clearly exprefs'd as to meet with a true solution, such as their authors design'd. It is on this account I have here corrected some faults in the answers last year, which are fully demonstrated by Mr. *J. Jope,* jun.

Quest. 75, *in diary* 1720. Put n for the time after Michaelmas 1719. Then 100 : 5 :: 320 : 16 and 1 : 16 :: n : 16n, the interest of 320 l. Then 320 $+$ 16n $=$ the amount of 320 l. 5 $-$ n $=$ the time the 202 l. was received before due.   1 : 5 :: 5 $-$ n : 25 $-$ 5n and 125 $-$ 5n : 100 :: 202 : $\dfrac{20200}{125 - 5n}$ $=$ value 202 l. at the day of payment. Then by the question 16n $+$ $\dfrac{20200}{125 - 5n}$ $=$ 202, which by reduction gives n $=$ 1'769076 $=$ 1 year 277 days 10 hours. So that the day of payment should be July 4th, 1721.

Paradoxes answered.

Par. 1 *answer'd.* In any deep well or coal-pit, from the bottom, if the shaft be streight, and there happen to be stars of any considerable magnitude in or near the zenith, you'll by a minute or two stedfast looking up discover them. Some astronomers have wells for that purpose.

Par. 2 *answer'd.* In several places where the water for some space runs under ground; as the river Guiadiana in Spain. But our own country of Warwick has such a bridge.

The river Ichene, from a Saxon word, to search or penetrate, is denominated the parish of Long Ichington. On a common near Over Ichington is a pool whose stream entereth the ground, and after an intricate paffage of half a mile, cometh ont again and paffeth along the brook. And Icheham near Windfor has its appellation from such a paffage.

Par.

Par. 3 _anfwer'd._ The prime meridian, from whence longitude is accounted both ways, paffes through the middle betwixt the fhip and ifland, and fo regard is had to the eaft and weft longitude, and not to the points of the compafs.

Par. 4 _anfwer'd._ The perfon was born in leap year, Feb. 29.

Queftions anfwer'd.

* I. _The_ 84th _queftion anfwer'd by_ Mr. Cha. Glover.

Let $a =$ the greater fide, $e =$ leffer. There's given the difference of the fides d, and the fum of their fquares z; which by involution, fubtraction, and evolution, this equation is found,

$$a = \frac{d + \sqrt{2z - dd}}{2}; \text{ fo } a = 38, e = 26 \text{ the folution.}$$

† II. _Queftion_ 85 _anfwer'd._

The cloud's height is 1747 yards by the prop. By fome tables and rules it is 1744·8; but taking no notice of the ☉'s alt. at the different places, 'tis 1746·3.

III. _Queftion_

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* I. QUESTION 84.

Put $z =$ the half fum of the two numbers, $d = 6$ the half difference, and $s = 2120$ the fum of their fquares. Then $z + d$ and $z - d =$ the two numbers; the fum of whofe fquares is $2zz + 2dd = s$. Hence $z = \sqrt{\frac{1}{2}s - dd} = \sqrt{1060 - 36} = 32$; and therefore 38 and 26 the two numbers.

† II. QUESTION 85.

Let S be the fun, C the cloud, and O the obferver, all in the fame vertical plane; upon the horizon OP let fall the perpendicular CP the height of the cloud; draw SC, and produce it to cut the horizon in A the fhadow of the cloud. Then OA will be given $= 2304$ yards, the angle $AOC = 20°$; and if the elevation CAP of the fun at A be
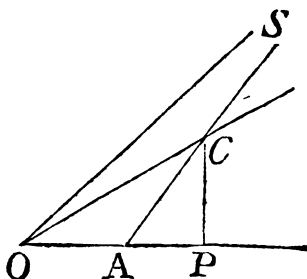
* III. *Queſtion* 86 *anſwer'd by Mr.* John Jope, *jun. of Loo, in Cornwall.*

$$x^4 + 2ax^3 + a^2 + 2b^2x^2 + 2ab^2x = \frac{a^2b^2R^2}{c^2} - a^2b^2 - b^4.$$ Where x is found $= 15 \cdot 103$: whence the courſe is S. 15° 21′ W. and the diſtance $= 57 \cdot 035$ leagues. The other courſe is S. 53° 21′ W. and the diſtance 92·139 leagues.

A full and compleat algebraic ſolution, by Mr. *Andrew*, room will not admit.

IV. *Queſtion*

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be ſuppoſed $=$ the elevation SOP at O, then the angle $CAP =$ 35°, the $\angle OAC = 145°$, and $\angle OCA = 15°$.——Hence, As s. $\angle ACO$: OA :: s. $\angle AOC$: $AC = \frac{s. 20°}{s. 15°} \times AO$; and, in the triangle APC, as 1 (rad.) : s. $\angle CAP$ :: AC : $CP = \frac{s. 20° \times s. 35°}{s. 15°} \times AO = 1746 \cdot 34$ yards, or near a mile for the height of the cloud.

But as 2304 are rather above 1 minute of a degree of a great circle, the $\angle CAP$ will be about 35° 1′, and then $CP = \frac{s. 20° \times s. 35° 1′}{s. 15° 1′} \times AO = 1745 \cdot 17$ yards the diſtance, a little leſs than before.

* III. QUESTION 86.

The meaning of this queſtion is, that three ſhips ſail from a port to three other ports in the ſame parallel of latitude; the one of them ſails direct ſouth a given diſtance, the other two between the ſouth and weſt, the differences of their courſes being given, and the diſtance between their two ports. Or, in other words, Given the baſe, the perpendicular, and the vertical angle of a triangle, to find the reſt.

Let C, P, A, O (ſee the laſt fig.) be the four ports; then $CP = 55$ leagues, $AO = 57$ leagues, and $\angle ACO = 38°$. Now, by prop. 13 Simpſon's Trigon. As 1 : cot. ½ $\angle ACO$ :: $2AO \times CP$: $\overline{OC + CA}|^2 - AO^2$; hence $OC + CA = \sqrt{AO^2 + 2AO \times CP \times \cot. \frac{1}{2}\angle ACO} = \sqrt{57^2 + 57 \times 110 \times \cot. 19°} = 146 \cdot 487$ the ſum of the ſides. And, by prop. 14 of the ſame, 1 : tan. ½ $\angle ACO$ :: $2AO \times CP$: $AO^2 - \overline{OC - CA}|^2$; and hence $OC - CA = \sqrt{AO^2 - 2AO \times CP \times \tan. \frac{1}{2}\angle ACO} = \sqrt{57^2 - 57 \times 110 \times \tan. 19°} = 33 \cdot 016$ the difference of the ſides. Then, the half ſum increaſed and diminiſhed by the half difference,

we

* IV. *Queſtion* 87 *anſwer'd.*

	hours	☉'s alt.	azim.	leng. ſhade
The 10th March.	VIII	17° 56'	65° 32'	318·2
Latitude 52.	IX	25 48	51 45	212·9
	X	32 13	36 14	163·4
	XI	36 29	18 47	139·23
	XII	38. 0	0 0	131·83
	I	36 29	18 47	139·23

Feet.

The figure will be triangular, the ſhadow at 8 and 1, being two of its ſides, and right lines; the third (the path of the nodus or top of the tree) a curve line, of the conic ſections, about 334 foot. The content 22200 ſquare feet = 210. 1 per. and 148 ſquare feet. Thoſe who have taken the horizontal diſtances with reſpect to the pole, inſtead of the azimuths, have given falſe ſolutions.

This

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we have 89·7515 and 56·7355 for the two diſtances *CO* and *CA*. Again, as 146·487 (ſum of ſides) : 33·016 (diff. ſides) :: cot. 19° (½ ∠ *OCA*) : tan. 33° 12' = half the difference between the angles *A* and *O*; and from the half ſum and difference thoſe angles are found = 104° 12' and 37° 48' the complements of 14° 12' and 52° 12' the two courſes required.

It is evident that this problem will be conſtructed, by deſcribing on the given baſe *AO* a ſegment of a circle to contain the given vertical angle; and then a line drawn parallel to the baſe at the diſtance of the perpendicular from it, will cut the circle in the vertex of the triangle.

* IV. QUESTION 87.

The piece of land in this queſtion is a triangle on the horizontal plane, of which two ſides are the ſhadows of the tree at 8 and 1 o'clock, and the third ſide the line deſcribed by the ſhadow of the top of the tree between the ſame two hours; and this third line will be right as well as the two former, and not a conic ſection, becauſe the ſun is in the equinoctial, it being the 10th of March old ſtile. The ſaid third line will alſo be directly eaſt-and-weſt, or perpendicular to the meridian or ſhadow of the tree at 12 o'clock.

Now

This queſtion may be wrought thus:

As rad. — — 90° 0'   As cotang. lat. 52° 0' 9·89280
To coſine lat.   52   ●   To radius — — — 10·00000
So is coſine of ⎱ 60   ○   So tang. altit.   17 56 9·51005
   the hour ⎰   To ſine azimuth 65 32 9·61724
To ſine of the ⎱ 17 56
   altitude   ⎰

As ſine 17° 56' : log. 103 :: ſine 72° 4' : log. 318, and ſo for the reſt. And you'll have ſeveral triangles with 2 ſides and an angle between them given, to find their contents.; which in one ſum gives the area of the whole more exact than by taking it as one ſingle triangle, by reaſon of the curve line in each of them.

V. *The*

Now, if P repreſent the pole, Z the zenith, and ☉ the ſun at any hour: Then are given P Z the co-latitude, P ☉ a quadrant, and ∠ P = the hour from 12 ; to find the ∠ P Z ☉, the ſun's azimuth or bearing at that hour. And, taking the extreme hours 8 and 1 in the queſtion, their azimuths will come out 65° 32', and 18° 47' ; which are the two angles A B P, C B P, contained by the meridian ſhadow B P, and the two extreme ſhadows B A, B C, the place of the tree being at B. Now, the ſum of theſe two angles is 84° 19' = the ∠ A B C, and their complements are 24° 28' and 71° 13' = the angles A and C. So that all the angles are then known.
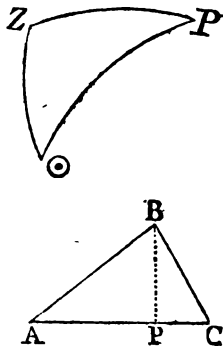
Again, the meridian altitude of the ſun being 38° = the complement of the latitude 52°, we ſhall have as 1 : tang. 52° :: 103 feet (the height of the tree) : 131·834 = B P the length of the meridian ſhadow. From hence, and the given angles, A P and P C are eaſily found = 289·73 and 44·837, and then the area = 22053·65 ſquare feet = 2·0218 roods.

* V. *The* 88*th* *Question answer'd by Mr.* L. Evan.

If $3\cdot633959$ be the area of a heptagon, whose side is 1; then put $x =$ the acres, $11 x =$ shillings, the price of 1 acre. $1 : 11 x :: x : 11 x x =$ the price in shillings of all the acres bought $=$ inches round the polygon; 6272640 inches $= 1$ acre.

$$3\cdot633959 : 1 :: 6272640 x : \frac{6272640\, x}{3\cdot633959} = \text{square each side.}$$

7 times the square root of that $= 11 x x$. That is $\sqrt{\dfrac{6272740\, x}{3\cdot633}}$

$= \dfrac{11 x x}{7}$, or $\dfrac{6272640 x}{3\cdot6339} = \dfrac{121 x^4}{49}$, or $\dfrac{307359360 x}{3\cdot633959} = 121 x^4$;

hence $307359360 x = 439\cdot7e9039\, x^4$, and $699006\cdot235 = x x x$. Then $88\cdot74999 = 88$ ac. 2 ro. 39 per. $= x$ the number of acres bought. $976\cdot24989$ shill. $= 48 l. 16 s. =$ the price of 1 acre.

VI. The 89th, or *Adraftea*'s question, by the omission of a line or two to limit it, admits of many answers.

> *For when the number of quantities sought exceeds the num-*
> *ber of given equations, the question is capable of innu-*
> *merable answers.*†

24

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* V. Q U E S T I O N 88.

Since the price of one acre in shillings is equal to 11 times the number of acres, it is plain that the price of all the acres will be 11 times the square of the number of acres; but the price of the whole is equal to the circumference in inches, therefore the circumference in inches is equal to 11 times the square of the acres.

Now if x denote the side of the heptagon in inches, $a = 3\cdot633912$ the area of a heptagon whose side is 1, and $b = 6272640$ the inches in an acre. Then $7 x$ will be the perimeter, and $\dfrac{a x^2}{b}$ the acres;

wherefore $7 x = \dfrac{11 a^2 x^4}{b^2}$; hence $x = \sqrt[3]{\dfrac{7 b b}{11 a a}} = 12377\cdot1 =$

the side. Then $\dfrac{a x^2}{b} = 88\cdot7487$ the number of acres.

† VI. Q U E S T I O N 89.

In the above original answer, it is justly remarked that the *data* are insufficient; for, to have limited the answers, there ought to have been three more conditions; so if three of the numbers of persons had been given, the question would have been confined to *one answer*, and the method of solution too easy to need any pointing out here.

$$\begin{array}{c} 24 \left\{ \begin{array}{l} \text{2 captains } 4l. \text{ each} = 8l. \\ \text{4 mates} \quad 2 \qquad = 8 \\ \text{14 failors } 10s. \qquad = 7 \\ \text{4 boys} \quad 5 \qquad = 1 \end{array} \right\} \begin{array}{c} l. \\ 24 \end{array} \end{array}$$

Mr. *Evan* has collected 100 true anſwers, which for bre-vity I omit.

* VII. *The 90th Queſtion anſwer'd by Mr.* Cha. Glover.

Let a = eldeſt ſon's portion, e = youngeſt, $aa = se$, and $s - a = e$ per queſt. this equation is produced,

$a = \sqrt{ss + \frac{1}{4}ss} - \frac{1}{2}s$. $a = 30901\cdot69943746$ or $30901l. 14s.$
$e = 19098\cdot30056251$ or $19098 l. 6s.$

† VIII. *The 91ſt Queſtion anſwer'd by Mr.* J. Andrew.

The tranſverſe diameter $16\cdot184053$ perches = $89\cdot01$ yards.
The conjugate diameter $12\cdot587597$ perches = $69\cdot23$ yards. Diſtance between the focus points $55\cdot9463$; thence to the extreme parts $44\cdot505$, doubled $89\cdot01$ added to the diſtance between the foci is the length of the tether 145 yards.

The

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* VII. QUESTION 90.

In this queſtion are to be found two numbers, of which the ſum is given, and the ſquare of the greater equal to the leſs multiplied by the given ſum. Or, it is required to divide a given number into two ſuch parts, that thoſe parts and the whole may be three numbers in geometrical progreſſion. Or, in other words again, to divide a given number according to extreme and mean proportion; which it is well known will not admit of an anſwer in integer num-bers.

Put s = 50000 the ſum, and x the greater part. Then $s - x$ = the leſs, and $xx = ss - sx$; hence $x = \dfrac{\sqrt{s} - 1}{2} \times s = 30901$

$\cdot6994375$, and conſequently the other part = $19098\cdot3005625$, as above determined.

† VIII. QUESTION 91.

Put $9x$ and $7x$ for the two axes in yards. Then $63xx \times$ $\cdot785398$ &c. = 4840 the ſquare yards in an acre. Hence x = $\sqrt{\dfrac{4840}{63 \times \cdot7854}} = 9\cdot890255$; conſequently $9x$ and $7x$ become $89\cdot0123$ and $69\cdot2318$ for the two axes. Then $89\cdot0123 +$ $\sqrt{89\cdot0123^2 - 69\cdot2318^2} = 144\cdot96$ = length of the tether.

The way for the horfe to graze juft an elliptical acre, is thus: Set up two ftakes or pins in the longeft diameter of the oval, 16. yards 6 inches and a quarter from the outfide. Put a ftring of 145 yards long round both ftakes, and tie the two ends together; at which knot let the horfe's mouth be fix'd: then in going about he will exactly fweep the oval, containing 4840 fquare yards, or one acre.

* *The Prize Queftion anfwer'd.*

In anfwering this queftion in hydroftatics, the philofophy of the gravity and preffure of fluids is to be confider'd: That at the firft moment the cock or adjutage is open'd, the liquid flows out with the fame velocity as a heavy body moves when fell from that height the liquor came, or the place of the refervoir. The water that enters the top or mouth of the pipe, moves as faft as that flowing out, at what

<div align="right">depth</div>

.* P R I Z E   Q U E S T I O N.

Put a = the altitude of the furface of the water above the deli-vering pipe, n = the area of the orifice or pipe, and m = $32\frac{1}{6}$ feet = 386 inches. Then proceeding as in page 4 of our new Math. Mifcel. $\sqrt{2\,ma}$ will be the velocity of the iffuing water, upon the fuppofition of the queftion, that it is equal to that of a heavy body after falling through the fpace a; but if, according to Sir I. Newton and fome others, the velocity be that which is acquired by falling through only $\frac{1}{4}a$, it will be $\sqrt{ma}$; which is to the former as 1 to $\sqrt{2}$, and therefore the time for the one fuppofition may be found from that of the other, by this proportion of 1 to $\sqrt{2}$.

Now in the former cafe with the velocity $\sqrt{2\,ma}$ per fecond, we fhall have $n\sqrt{2\,ma}$ for the quantity run out per fecond; and there-fore $n\sqrt{2\,ma} : \mathcal{Q} :: 1$ fecond $: \dfrac{\mathcal{Q}}{n\sqrt{2\,ma}}$ = the feconds in which the quantity $\mathcal{Q}$ will be voided.

Then, for the king, $\mathcal{Q}$ = $12\frac{1}{7}$ hogfheads = $12\frac{1}{7} \times 63 \times 231$ or 176715 cubic inches, n = $1.75^2 \times .7854$, and a = $10\frac{1}{2}$ feet = 126 inches; with which numbers $\dfrac{\mathcal{Q}}{n\sqrt{2\,ma}}$ becomes 235.565 feconds, or 3 min. $55\frac{1}{2}$ fec.

And, for the people, $\mathcal{Q}$ = 20 hogfheads = 291060 inches, n = $2^2 \times .7854$ = 3.1416, and a = 22 feet = 264 inches; which numbers give 205.22 feconds = 3 min. $25\frac{1}{4}$ feconds; both nearly as in the original anfwer.

But if the other fuppofition be ufed, of $\sqrt{ma}$ velocity per fecond; then each of the above times muft be multiplied by $\sqrt{2}$.

depth foever, in an equal cylinder.   Whereas a heavy body
moves flow at firft fetting out, and continually receives a new
impulfe of gravity, which when it has fallen the length of
the water-pipe, is equal in velocity to that column of water.
Then as a body accelerates with the odd numbers 1, 3, 5, &c.
the water going out as faft the firft fpace, as a weight falls in
the fecond ; confequently muft be as Gravefand, in his Ma-
thematical Philofophy, page 188, N° 378, fays,

   " In the time in which a body falling freely, goes through
" the height of the liquid above the hole, a column of the
" liquid flows out equal in length to twice that height."

   On this principle was the queftion compofed, having
Gravefand then before me ; which is plain from the queftion
itfelf, the. word [acquired] meaning no other, than that
the water moved as faft as the body, when it had fallen the
height of that liquid : But the defign of putting it in thofe
words was to prevent fuch who had not fkill enough in phi-
lofophy, ftamping a folution to it.

   The king ufed 765 gall. = 12½ hogfheads per day.   The
bore 1·75 inch fquared × by 252 double height ÷ 294·12
gives 2·6579 w. g.) 765 (287·9 times (the height) for the
quantity.   □ 6" = 3600) 192 (·05333 inch, the fpace ac-
celerated in 1 third.   Then 10½ feet = 126 inches — ·05333
gives 48·621 thirds multiplied by 287·9 is 13994·819 thirds =
3' 53" 14'''.   *The anfwer.*

          The people ufe 1260 gallons per day.

Height dupla 528 × 4 dia. fq. ÷ 294·12 = 7·18 w. g.

1260 ÷ 7·18 = 175·49 fuch columns $\sqrt{\frac{22}{16}}$ = 1·17 ×

175·49 = 205·3233 = 3' 25" 32'''.   *The anfwer.*

Of the Eclipfes in 1722.

   In the annual revolution of that glorious body the fun,
three times will the dark body of the moon interpofe and
eclipfe its light from us ; and twice will the earth interpofe
between the fun and moon, and deprive her of a borrow'd
light.

   1. Sun eclipfed, Saturday the 6th of January, 6 min. after
11 o'clock in the morning, but not vifible to us in England :
the moon's latitude caufing the fhadow to fall in the more
fouthern countries.

Diary Math.   **U**

2. Sun eclipfed, Saturday the 2d of June, 40 min. after 7 in the evening, but invifible.

3. Moon eclipfed, total and vifible, on Monday the 18th of June, at 2 in the morning.*

	Beginn. h. m. s.	Middle h. m. s.	End h. m. s.	Digits h. m. s.
Adraftea's calcul. Coventry	0 3 41	1 40 20	3 17 0	13 39 40
Coventry by Chattock	0 3 43	1 40 27	3 17 11	13 42 5
Aftronomia Britan. London	0 13 51	1 54 31	3 35 11	14 13 49
London by Silvia	0 13 32		3 27 20	13 15 0
Lond. Flamft. Table Gibbon	0 13 16	1 51 33	3 29 50	13 56 2
London by Leadbetter	0 19 50	1 56 37	3 33 24	13 32 0

4. Sun

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* This eclipfe of the 18th of June was obferved

1. At *Greenwich* by Dr. *Halley* thus.

App. Time.

h.	m.	
13	12	} Between thefe two times the eclipfe became total.
13	19	}
15	26	} Between thefe times the end.
15	27	}

2. At *Port Royal* in *Jamaica* by Capt. Candler.

h.	m.	s.	
6	59	10	The eclipfe began.
8	7	50	Immerfion.
9	11	0	Emerfion.
10	19	40	The end.
8	39	25	Whence the middle.

So that the diff. of long. between Port Royal and Greenwich will be 5 h. 6 m. 50 s. or 5 h. 6½ m. from London; that is, 76° 37¼'.

3. At *Berlin* by Mr. *Chriftifried Kirck*.

h.	m.	s.	
12	59	55	Beginning.
14	8	8	Immerfion.

Berlin is 54 m. of time, or 13° 30' of long. eaft of London.

4. Sun eclipfed, vifible, Tuefday the 27th of November, 50 minutes paft 2 in the afternoon.*

	Begins	Middle	End	Digits
	h. m. s.	h. m. s.	h. m. s.	d. m. s.
By Aftronomia Carolina	I 43 31	II 47 53	III 48 20	5 15 31
at Coventry				
Scientia Stell. Coventry	I 31 42	2 41 23	3 47 10	6 3 56
Leadbetter, London	I 50 52	2 58 17	4 1 20	5 47 0

5. Moon eclipfed, vifible, Tuefday the 11th of December, 21 minutes paft 3 in the afternoon.

	h.	m.
The beginning at	II	7
Greateft obfcuration	III	21
The end　—　—	IIII	34
Whole duration　—	2	27
Digits eclipfed　—	5	29

New

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* This eclipfe of the 27th of November was obferved thus.

1. At *Greenwich* by Dr. *Halley.*

Tempora.
h. m. s.
1 29 16 Eclipfin jam inceptam vidi.
3 43 25 Finis eclipfeos dubius, ob limbum folis afperum & undulantem nec fat bene definitum.
3 43 45 Certe defierat eclipfis.

2. *At London* by Mr. *G. Graham.*

App. Time.
h. m. s.
1 28 38 Beginning.
3 43 22 End .
2 14 44 Duration.
5·716 dig. Quantity eclipfed.

3. At *Wakefield* in *Yorkfhire* by Mr. *Hawkins.*

h. m. s.
1 21 0 Beginning.
3 30 3 End.
The fun's diameter obfcured fomewhat more than 5 digits.

4. At *Cambridge* in *New England* by Mr. *T. Robie.* .

h. m. s.
9 25 45 The end of the eclipfe.

Mr. *Owen Harris,* an ingenious Schoolmafter in *Bofton,* fays he obferved the end at about 9 h. 26 m.

New Paradoxes.

Par. 1. There are divers remarkable places upon the terraqueous globe, whofe fenfible horizon is commonly fair and ferene; and yet 'tis impoffible to diftinguifh properly in it any one of the intermediate points of the compafs; nay, not fo much as two of the four cardinals themfelves.

Par. 2. There are three diftinct places of the earth, all differing both in longitude and latitude, and diftant from one another two thoufand miles compleatly; and yet do all bear upon one and the fame point of the compafs.

Par. 3. There are three diftinct places on the continent of Europe, lying under the fame meridian; and at fuch a diftance, that the latitude of the third furpaffeth that of the fecond, by fo many degrees and minutes exactly, as the fecond furpaffeth the firft; and yet the true diftance of the firft and third from the fecond (or intermediate place) is not the fame by a great many miles.

New Queftions.

I. *Queftion* 92, *by* Mr. J. Andrew.

How much to mathematic art is due,
None truly know but thofe that it purfue:
The lofty paths trac'd by great Newton's hand,
Or thofe whofe works like his will ever ftand,
Long as Ægyptian piles, but yet more bright,
And to fucceeding ages give a pleafing fight.
Gen'rous Halley, ne'er equall'd yet we knew;
Great Britain's fons will long his numbers view;
Their wond'rous works with admiration tell,
What pains they took, and how they did excel.
    You ladies, who in numbers' fports are known,
Let's know the greateft fruftum of a cone,
(In ale gallons) in a femi-fpheroid,
Tranfverfe thirty, and twenty inches wide.

II. *Queftion* 93, *by* Mr. C. Mafon.

Seen, June the ninth, a lofty tower to be,
In height two hundred fifty foot and three.
Upon its top a veering fane, but I
At that fame time could not its height defcry:

The fun then fhone, I did the fhadow take
The tower and fane did both together make;
Whofe length I found the height o'th' tower to be;
Its bearing north north-weft appear'd to me.
In latitude, degrees juft fifty-four;
The height defcribe; the fane's above the tower.

III. *Queftion* 94, *by* Mr. Richard Whitehead.

I by an ancient writing underftand,
My grandfather inclos'd a piece of land
With three brick walls, and then a garden made;
Green were the walks, and cooling was the fhade:
A circling hedge of yew in which he plac'd,
And artful knots of flowers the circle grac'd,
Each wall was touch'd, by whofe periphery
In the fouth wall you might a door-place fee,
Juft at its point of contact: Thus 'was cut
Into two fegments, as in margin put.   39½, 30½ *yards.*
From corner oppofite to that fame wall,
A perpendicular's fuppos'd to fall;
Its fegment's product then in yards will be,   1181⅔⁰⁷⁵ⁱ.
I pray, ye ladies fair, declare to me
The garden's true content, length of each wall,
Circle's diameter, as they do fall?

IV. *Queftion* 95, *by* Mr. Alex. Naughley.

As I happen'd once with a gauger to drink,
Who, proud of his art, would venture his chink,
That by right *data* he'd find to a gill,
Any tun's content in malt, wine, or ale.
Good luck it was then, a maltfter was there,
Put on by the hoft, laid a wager of beer.
The dimenfions given here you may fee,
Of his own by-tub, he could not tell me,
What bufhels it held, to a nicety.
The leffer diam. was inches thirty-two,
Segments, by cutting the diagonals, two,
Were twenty and thirty, appeared to view.
Then the gauger, incenfed, wrought with his pen,
Cane, tape, rule, and tables; but all was in vain:
So, ladies, your aid he begs for this bout,
That the tale of a tub turn him not out.

V. Question 95, by Mr. Joseph Smith.

Near to the borders of the German main,
There lies a piece of land, an even plane,
In form triangular, but not right:
The fences of the land lie very ftreight;
The fum of the fides make twice forty-eight.
The third part of the longeft fence, I know,
Is juft the diff'rence of the other two;
And two chains leffer than the fhorteft fence,
Makes true the bafe's ſegment's difference.
Three men they bought this land the other day,
And I muft part it for them, as they fay,
By art, and in a new unheard-of way.
In this fame ground, a certain point there lies,
That if the field was hung, would poize
It equally above our earthly ball,
That neither fide would rife, nor neither fall:
To this fame point, their fences I muft bring
From the three angles, by a chain or ftring;
The length o'th' fences of each fev'ral part,
I do require, of all you fons of art.

VI. Question 97, by Mr. R. Tapper.

An only fon I am; my age I fain would know;
But the regifters my age they cannot fhow:
Yet all this I do remember very well,
Which makes me think my age you'll quickly tell.
If to double my age, you place the fquare root,
Of my age doubled, with five years more to boot;
Square the laft fum, and add it to the other,
The aggregate of all thofe fums make together
Twenty-two hundred and fixty, lefs by four:
My age to me, quickly pray declare.   16 Jan.
And canon true, to find it out this year.   1724½.

VII. Question 98, by Mr. T. Rafberry.

Three fifters jointly do agree
To venture portions in fouth fea;
But fickle fortune prov'd fo crofs,
That each of them fuftain'd a lofs:
The diff'rence of their loffes be,
A, two thoufand more than B,
And nine thoufand more than C.
But one thing more I will declare,
Of the eldeft fifter's lofs, the fquare
Is equal t'th' fquares o'th' other two.
Each lady's lofs pray tell me true.   The

The Prize Queſtion, by Adraſtea; *the anſwerer may by lot
win* 10 *of theſe diaries.*

Afpire my genius ! help my rhiming mufe,
In themes I in my native country chufe :
Whilſt others plow the waves and tread the ſtrands
Of diſtant oceans, and of foreign lands;
To fill the mouth of fame with ſomewhat new,
(No matter 'tis how much of it be true).
From alps or mountains, ſtories ſtrange they bring,
Of defert caves, or horrid monſters ſing.
Tell how Vefuvius' fulph'rous darts do fly,
Or Ætna's ſmoke obfcure the azure ſky;
Or magnify the hazards they have run,
Scylla's and Charybdis's pointed rocks to ſhun.
    Such tales we take in truſt from thofe who rove,
Tho' none give rules by which the truth to prove.
    But this by numbers may be explained be,
By thofe who never did the cavern fee :
In Derbyſhire, a wonder of the Peake
Is Eldon-hole, as poets often fpeak;
Whofe depth exactly, none cou'd e'er defcry,   }
Tho' atheiſt Hobbs his utmoſt ſkill did try,   }
Who wrote De Mirabilibus Pecci.   }
    And burlefque Cotton does ſtrange tales rehearfe,
In ruſtic words, and hudibraſtic verfe,
How he this monſtrous orifice did plumb,
But cou'd not at the bottom of it come,
With fixteen hundred yards of rope let loofe;
And tells a ſtory of a woman's goofe :
Fabulous the one, fo may the other be,
Erroneous too, without philofophy;
Extenſion of the rope might him deceive,
And fmall proportion which the plumb wou'd have
To fuch a length; and part in water drown'd,
When in this vaſt abyfs within the ground.
    But I the depth have found, exactly true,
By gravity; a method fomething new.
As heavy bodies do accelerate,
In fpaces known firſt to our Newton great.
Four pond'rous ſtones into the well let fall
In meafur'd time, agreed in numbers all;
A pendulum, ſixty-one inches long,
By which the time I meafur'd (was not wrong)
Vibrated freely, whilſt that each ſtone fell
Eight times; by which the depth I'd have you tell.
Allowing rightly for th' approach of found,
That your own works may not themfelves confound.

        A

A farther Differtation on the Engine, continued from the laft Diary.

The laft diary gave you the calculation of an engine wrought by the preffure of the atmofphere; what materials were capable of raifing any quantity of water, not exceeding 3co hogfheads an hour, at any depth under 100 yards. The general ufe it has defervedly obtained in mines, makes it needlefs to fay any thing more of its fervice: A philofophical and mechanical defcription of the machine, is too large for my room here; I fhall at prefent only obferve, that the boiling water in a clofe veffel, has an expanfion and elafticity in fteam, almoft incredible. One cubic inch of water will produce or fill 13300 cubic inches with fteam, each with an elafticity to raife a pound avoirdupois, in the common way of working fuch engines. But each inch may be made to raife 10 or 20 atmofpheres, viz. 756 tun: A thing not hitherto taken notice of.

I have been led, through curiofity, many years to obferve moft engines of any account for fervice; and to perufe all books of engines I could in any language; but 'tis very ftrange, to find none of them fhou'd write in fuch a practicable method, as might inform or teach others, nor underftand mechanics and numbers.

Enough either to guide them towards truth, or fkreen them from grofs errors, when they give us a neat cut of an engine, turn'd by a current of water, or by wind or horfes; and then tell us a romantic ftory, how the fame may be wrought by a man or two men. One would think they never knew that the fervice of one horfe equall'd the ftrength of five or fix men; or that an overfhoot wheel will exceed the ftrength of five or fix and twenty horfes, when fuitably apply'd. They generally perplex the motions, one number giving power or velocity, and the next deftroying it; making the friction great, and the working parts ill and unferviceable.

Engines are only valuable, as they carry a mathematical demonftration of their power and certainty. And could engineers confider that maxim, *What's gained in force, is loft in time; and what's got in time, is loft in force;* and Sir Ifaac Newton's three laws of motion or nature; men would never entertain fuch ridiculous whims as perpetual motions, or pretend to do more than is poffible, unlefs the Creator alter the whole fabric of nature.

Paradoxes

1723.

Paradoxes anſwered.

1 Par. anſw. UNDER either of the poles.

2 Par. anſw. All places differ in both longitude and lati-
tude, at what diſtance ſoever, with reſpeƈt to either poles
bear upon the ſame point of the compaſs. Or they may be
in the ſame ſpiral rumb; elſe underſtood as in the earth, and
not upon it.

3 Par. anſw. The oblate ſpheroidal figure of the earth will
cauſe ſuch a difference.

Queſtions anſwer'd.

* I. Mr. C. Maſon's anſwer to the 92d queſtion.

Accept, fair nymphs, this free-will offering,
Which I with rev'rance to your altar bring;
Tho' my poor mite ye need not, nor my praiſe,
For your own works will laſting trophies raiſe;
But gratefully acknowledge that I owe
The art to you, which theſe ſolutions ſhow.

Let

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* I. QUESTION 92.

To find the greateſt fruſtum *A E G C* of a cone that can be in-
ſcribed in a given ſemi-ſpheroid *ABC*, the
baſe of the cone being the ſame as that
of the ſpheroid, whether it be oblate or
oblong, that is whether the revolving
axe *A C* be the leſs or the greater axe of
the ellipſe.

Put $r = AD$ the ſemi-revolving axe,
$f = DB$ the ſemi-fixed axe, and $x =$
DF the altitude of the fruſtum. Then,
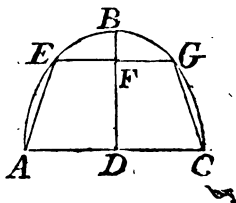
Let the femi-tranfverfe $15 = b$, and femi-conjugate $10 = c$, length of the frumftum $= a$, the difference put $= b - a$, and the femi head diameter $= e$. Then,

$$bb : cc :: bb - aa : \frac{bbcc - ccaa}{bb} = ee.$$ Which re-duced gives $a = 10.606601$, and $e = 7.075$, and $2e = $ lefs diameter $= 14.15$ inches; hence the content in ale gallons 8.6915.

Mr.

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by the ellipfe, $ff : rr :: ff - xx : EF^2 = \dfrac{ff - xx}{ff} \times rr$; hence the folidity of the fruftum will be

$$\overline{rr + rr\sqrt{\frac{ff - xx}{ff}} + rr \times \frac{ff - xx}{ff}} \times \frac{3.1416 x}{3},$$ and there-fore $x \times \overline{1 + \sqrt{\frac{ff - xx}{ff}} + \frac{ff - xx}{ff}} = $ a maximum.——Or, put $zz = \dfrac{ff - xx}{ff}$, then $xx = ff \times \overline{1 - zz}$, and the maxi-mum $= \sqrt{1 - zz} \times \overline{1 + z + zz}$; which put into fluxions and reduced, we have the equation $1 + z - 2z^2 - 3z^3 = 0$; whofe root z is $= .6464881$ very exact. Hence $z = \sqrt{1 - zz} \times f = .762924 f$, and the content of the greateft fruftum $= .762924 frr \times \dfrac{3.1416}{3} \times \overline{1 + z + zz} = 1.649344 frr$.

Now in the cafe of the oblong fpheroid, $f = 15$, $r = 10$, x the height $= .762924 f = 11.44386$, and the content $1.649344 frr = 2474.016$ inches $= 8.773$ ale gallons.

But if the fpheroid were oblate, then $f = 10$, $r = 15$, $x = 7.62924$, and the coufent $= 3711.024$ inches $= 13.1597$ gallons.

Corollary.

From this folution it appears, that the value of x, or the height of the fruftum, will be always the fame, whatever the revolving axe AC may be; the faid height being to the femi-fixed-axe, or DF to DB, as $.762924$ to 1.——And the content $1.649344 frr$ of the fruftum $AEGC$ is to the femi-fpheroid ABC or $2 frr \times \dfrac{3.1416}{3}$, as 2.474016 to 3.14159 &c. or as $.787504$ to 1.——Alfo, the fruftum in the oblate is to the fruftum in the oblong femi-fpheroid, as the longer axe to the fhorter, which is the fame pro-portions as the fpheroids themfelves are in by Cor. 8 page 277 of *Menfuration*.

Mr. *Ri. Tapper*, by the doctrine of fluxions, gives this equation, $x^5 + \frac{5}{3}x^4 + \frac{4}{2}x^3 - \frac{2}{4}x = \frac{1}{4}$. Here the flowing quantity $x = ·64638$. Hence this general theorem,

As 1 : the conjugate diameter of a spheroid :: ·64638 : the lesser diameter of the largest conic frustum that can be inscribed. Whence

The lesser diameter — — 12·9277 } inches.
Height of the conic frustum 11·4455 }
The solid content — — 8·7734 ale gallons.

But Mr. *Andrew*, the proposer, gives this general theorem, $x^6 - 425 x^4 + 67500 x^2 = 3796875$: and the lesser diameter $= 12·9297$, and the content $= 15·4587$ ale gallons.

* II. *The 93d Question answer'd by* Sylvia.

If the bearing of the shadow be N. N. W. the sun must be upon the S. S. E. point, his azimuth then being 22° 30′ from the south, and his declination being the 9th June 23° 30′. In the latitude of 54° his altitude is 58° 2′.

As the tangent of 45° 0′ — — — 10·0000000
To the tangent of 58 2 — — — 10·2047732
So is the logar. 253 foot — — 2·4031204
To the logar. 403·4 — — — 2·6078937

The height of the tower and fane together, but the fane's above the tower just 152·4 foot.

III. *The*

In the spherical triangle $Z P \odot$, given $P Z$ the co-latitude $= 36°$, $P \odot$ the co-declination $= 66° 30′$, and the angle $Z =$ the azimuth from the north $= 157° 30′$; to find the side $Z \odot = 31°$ 58′ $=$ the co-altitude. Hence the altitude itself is 58° 2′ $= \angle BAC$ in the second figure, in which the shadow $A B =$ the tower $B D = 253$; then, by plane trigonometry, as radius : tang. $\angle BAC$ :: $A B : B C =$ the height of the tower and vane together; from which taking away the height of the tower $B D$, there remains $D C =$ the height of the vane, as in the original solution.
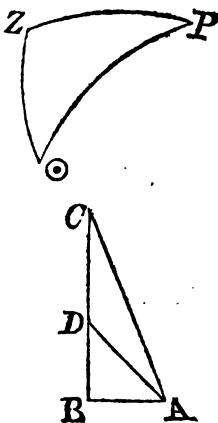
＊ III. *The 94th Question answer'd by Mr.* Ri. Tapper.

Let $a =$ the greater segment taken from the perpendicular, $e =$ lesser segment, and $s =$ their sum $= 70$, p their product $1181\frac{2071}{600}$ yards. There comes out this equation,

$$a = \tfrac{1}{2}s + \sqrt{\tfrac{1}{4}ss - p} = 41\cdot6090925304966547$$
$$e = \tfrac{1}{2}s - \sqrt{\tfrac{1}{4}ss - p} = 28\cdot3909074695033453$$ yards.

Put x for the unknown tangent, $b =$ the greater segment, $d =$ the lesser, from whence this equation is brought out

$$x = \frac{dd + aa - bb - ee}{18} = 16\cdot404053014973987049944 5.$$

Hence the length of the walls are,

   Longest 70,
   Next - 55·90453014973987049944 5,
   Shortest 46·9045 &c.

For the perpendicular's length, let $a =$ the shortest side; then, by Eucl. I. 47, $\sqrt{gg - ee} = 37\cdot40536$ yards.

Hence the area $= 1309\cdot1876$ square yards $= 1$ ro. 3 per. &c.

To find the angle subtended by the perpendicular, and made by the shortest side and shortest segment.

As the less segment : radius :: perpendicular : tang. $52°\ 48'$.

As radius : tang. of $\frac{1}{2}$ last angle :: lesser segment $30\cdot5$: $15\cdot14$, half of the diameter; so the diameter is $30\cdot28$.

            IV. *The*

＊ III. QUESTION 94.

In this question we have given, in the triangle ABC, the base $AC = 70$, the rectangle of the segments of the base, made by a perpendicular, $AD \times DC = 1181\frac{2071}{600}$, and the segments of the base made at the point of contact of the inscribed circle, viz. $AE = 39\frac{1}{2}$, and $CE = 30\frac{1}{2}$; to determine the triangle.
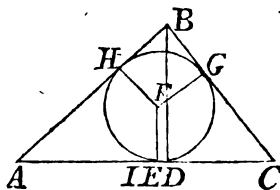
Algebraical Solution.

Put $s = 35 = AI = IC$, $p = 1181\frac{2071}{600} = AD \times DC$, and $z = ID =$ half the difference between AD and DC. Then $AD = s + z$, and $DC = s - z$; hence their product $ss - zz = p$, and therefore $z = \sqrt{ss - p}$. Then $AD = AH = s + \sqrt{ss - p}$, and $DC = CG = s - \sqrt{ss - p}$.——Again, since

IV. *The* 95*th Question answer'd by Mrs.* Eliz. Dod.

> If gaugers wou'd their bufinefs mind,
>   And follow their excife;
> They their account therein would find,
>   Without this ftir and noife;
> Let 'em no more their boafted art
>   Extol, fince 'tis our aid
> That does the tub's content impart,
>   Tho' they for that are paid.

The

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fince BH is $= BG$, we fhall have the difference of the fides $AB - BC = AH - CG = AE - EC = 9$; then, by a known rule, $AE - EC : AD - DC :: AC : AB + BC$; the fum of the fides being then known, from it and their difference the fides themfelves are eafily found. Alfo $BD = \sqrt{BA^2 - AD^2}$, and $\frac{1}{4} BD \times AC =$ the area.——Laftly, the double area of the triangle being divided by its perimeter, the quotient will be the radius FE of the infcribed circle.

Geometrical Conftruction.

Let I be the middle of the given bafe AC, and E the point of contact with the circle. By Eucl. II. 14, make a fquare equal to the given rectangle of the fegments of the bafe, which call S^2; then take ID equal one leg of a right-angled triangle of which S is the other leg and AI the hypothenufe; fo fhall AD, DC be the fegments of the bafe made by the perpendicular.——For, by Eucl. II. 5, $AI^2 = AD \times DC + ID^2 = S^2 + ID^2$ by the conftruction; therefore AI, S, and ID form a right-angled triangle by Eucl. I. 48.

Again, take BG or BH a fourth proportional to $2 IE$, ED, and AC; which being added to $AH = AE$, and to $CG = CE$, the two fums will be the two fides AB, BC, of the triangle.—— For, by Eucl. III. 37, $AE = AH$, $CE = CG$, and $BH = BG$; and it remains only to prove that BG or BH is the 4th proportional mentioned above. Now, by Simpfon's Geom. Cor. 2. 9. II, as $AB - BC : 2 ID :: AC : AB + BC$; but $AB - BC (= AH - CG = AE - EC) = 2 IE$, and $AB + BC = (AH + HB + BG + GC =) AC + 2 BG$; therefore the proportion becomes $2 IE : 2 ID :: AC : AC + 2 BG$; hence, by divifion, $2 IE : 2 ED :: AC : 2 BG$, or $2 IE : ED :: AC : BG$. Q. E. D.

The calculation from hence is very eafy and evident.

Diary Math.   X

The greateſt diameter 48. Leſſer 32. Depth 30 inches.
Content 17·764834 malt buſhels.*

<p align="center">† V. *The 96th Queſtion anſwer'd.*</p>

The three ſides of the triangle are 42, 34, and 20 chains.
The internal fences 24·586, 18·773, and 12·238. The content 33·6 acres.

Divide each ſide of the triangle into two equal parts, from
whence draw lines to the angles oppoſite; the point in which
theſe interſect is the center of gravity of the triangle; and
and where it would be, if hung up, equally poiſed.

<p align="right">VI. *The*</p>

<p align="center">• IV. **QUESTION 95.**</p>

$ABCD$ being the tub, we have given $DC = 34$, $AE = EB = 30$, and $DE = EC = 20$.

Upon the middle of the baſe
of the iſoſceles triangle DEC
let fall the perpendicular from
the angle E; and from the top
of the tub let fall the perpendicular BF.   Then, in the
right-angled triangle DEG,
$EG = \sqrt{DE^2 - DG^2} = \sqrt{20^2 - 16^2} = 12$; and in
the ſimilar triangles DEG, DBF, as $DE = 20 : EG = 12 ::$
$DB = 50 : BF = 30$. Alſo, by ſimilar triangles, $ED : DC$
$:: EA : AB = 48$. Hence the content $= ·7854 \times BF \times$
$$\frac{AB^2 + AB \times DC + DC^2}{3} = 30 \times \frac{48^2 + 48 \times 32 + 32^2}{3}$$
$\times ·7854 = 12160 \times 3·14159$ &c. $= 38201·77$ cubic inches $=$
17·7648 malt buſhels.
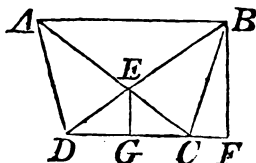
<p align="center">† V. **QUESTION 96.**</p>

Let AC be the baſe or longeſt ſide of the propoſed triangle
ABC, and BD the perpendicular.——Put $z = BC$ the
ſhorteſt ſide, and $y =$ the
other ſide AB. Then, by the
queſtion, $z - 2 = AD - DC$,
and the greateſt ſide AC (or
$AD + DC) = 3·y - z$, alſo
the ſum of all the three ſides
is $4y - 2z = 96$, or $2y - z$
$= 48$. But, by the nature of
the triangle, $AC : AB + BC$
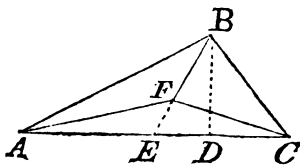
<p align="right">:: AB</p>

* VI. *The 97th Question answer'd by Mr.* C. Mason.

It is evident this question is composed from that in page 225 of Ward's Mathematician's Guide.

Suppose $\frac{aa}{2}$ = to his age.

$aa + a + 5 = 47$. Involved is
$a^4 + 2a^3 + 12aa + 11a + 30 = 2256 = b$. Then by completing the square will be produced this canon,

$\sqrt{\sqrt{b + 0.25} - 5.25} - 0.5 = a$, and $\frac{aa}{2} = 18$ years ol'.

To

$\because AB - BC : AD - DC$, or $3 . \overline{y - z} \times \overline{z - 2} = \overline{y + z} \times \overline{-}$;
hence $3 . \overline{z - 2} = y + z$, or $2z - y = 6$. From this equation, and the one above, viz. $2y - z = 48$, we easily find $z = 20$, and $y = 34$. Consequently the third side $3 . \overline{y - z}$ is 42.

Now the point F upon which the triangle will be in equilibrium is the center of gravity; and lines drawn through the center of gravity, from the angular points, bisect the opposite sides; that is, BF produced bisects AC in E; also the distance between the angular point and the center of gravity is two-thirds of the whole line, that is $BF = \frac{2}{3} BE$. But, by theor. II book 3 Simp. Geom. it is $2BE^2 + \frac{1}{2}AC^2 = AB^2 + BC^2$; hence BF $(= \frac{2}{3}BE)$ $= \frac{2}{3} \sqrt{\dfrac{AB^2 + BC^2 - \frac{1}{2}AC^2}{2}} = 12.238373$. In the same manner AF is $= \frac{2}{3} \sqrt{\dfrac{AB^2 + AC^2 - \frac{1}{2}BC^2}{2}} = 24.5854519$, and $CF = \frac{2}{3} \sqrt{\dfrac{AC^2 + CB^2 - \frac{1}{2}AB^2}{2}} = 18.77350379$.

* VI. QUESTION 97.

The method of completing the square in the above original solution is thus. —— Since $a^4 + 2a^3 + 12a^2 + 11a + 30$ is $= \overline{aa + a + 5}|^2 + aa + a + 5 = b$; by completing the square, we have $aa + a + 5 = \sqrt{b + 0.25} - 0.5$; and, by completing the square again, it is $a = \sqrt{\sqrt{b + 0.25} - 5.25} - 0.5 = 6$. And then $\frac{1}{2}aa = 18$.

X 2

To this Queſtion Cælia Beighton *thus anſwers.*

    I've view'd your query, Mr. Tapper, well,
And found a rule by which your age to tell.
" Extract th' ſquare root o'th' number giv'n,
" Quote or remainders forty-ſeven ;
" From whence take five, and there remains
" Juſt forty-two, which with ſmall pains
" You may extract, the root is ſix,
" And ſix remains ; therefore I fix
" The ſquare of ſix your double age :
" From hence you have a theorem true,
" Which now I have explain'd to you.

* VII. *The* 98*th Queſtion anſwer'd by Mr.* Lewis Evan.

    Put a, e, u = their ſeveral loſſes, b = 2000, and c = 9000. Then

$$\left.\begin{array}{l} a = b + c \\ e = c \\ u = b \end{array}\right\} + \sqrt{2bc} = \left\{\begin{array}{ll} 17000 & A \\ 15000 & B \\ 8000 & C \end{array}\right\} \text{loſt.}$$

The

    The theorems, in the original ſolution above, for determining the values of the three quantities required, are found thus.
    Denoting the two differences between the greateſt and each of the other two by b and c, as above, and the leaſt quantity itſelf by x ; then $x + c$ = the greateſt, and $x + c - b$ = the middle one : hence, by the queſtion, $\overline{x + c}^2 = x^2 + \overline{x + c - b}^2$; from which equation we have $x = b + \sqrt{2bc}$.
    Then $x + c - b = c + \sqrt{2bc}$,
       and $x + c = b + c + \sqrt{2bc}$,
which are the three quantities required.

* The Prize Queſtion anſwer'd.

Auguſt 18, 1718, Adraſtea let fall 3 ſeveral ſtones into Eldon-hole, which fell with little or no obſtruction, and accelerated in 9, 11, and 10 ſeconds from their delivery to to the ſound's reaching the ear: Sir Iſaac Newton ſays heavy bodies fall 16·5 foot the firſt ſecond, then 3, 5, 7, 9, &c. times ſo much in the ſucceeding ſeconds, and that ſound moves 968 feet in a ſecond.   Then $10'' \times 10'' = 100 \times 16\cdot5$, 1650 feet $\div$ by 968 $= 1'' \, 42'''$ for the approach of ſound.   So the ſtone was falling. but $8\frac{1}{4}''$; $8\cdot25 \times 8\cdot25 = 68\cdot0625 \times 16\cdot5$ $= 1123$ feet $= 374\cdot34$ yards.

But

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* PRIZE QUESTION.

This problem is of the nature of Sir I. Newton's 50th prob. in his Univerſal Arith. who has there given the true method of ſolution much in this manner.

Put x for the depth of the hole, $a = 16\frac{1}{12}$ feet the diſtance fallen by a body in the firſt ſecond of time, and $b = 1142$ feet $=$ the velocity of ſound per ſecond; alſo $t =$ the given time of hearing the ſound, found by the experiment.——Then, by the nature of falling bodies, $\sqrt{a} : \sqrt{x} :: 1'' : \sqrt{\dfrac{x}{a}} =$ the time of the ſtone's falling to the bottom; and, by the uniform motion of ſound, $b : x :: 1'' : \dfrac{x}{b} =$ the time in which the ſound will aſcend through the ſpace x.   Then the ſum of theſe two times will be equal to the whole time, that is $\dfrac{x}{b} + \sqrt{\dfrac{x}{a}} = t$.—— Now the times in which pendulums make an equal number of vibrations, being as the roots of the lengths, and a pendulum 39·2 inches long vibrating 8 times in 8 ſeconds, we ſhall have $\sqrt{39\cdot2}$: $\sqrt{61} :: 8'' : 8\sqrt{\dfrac{61}{39\cdot2}} = 10'''$ (extremely near) $= t$ the time in which a pendulum of 61 inches ſwings 8 times : then the above theorem $\dfrac{x}{b} + \sqrt{\dfrac{x}{a}} = t$ becomes $\dfrac{x}{1142} + \sqrt{\dfrac{x}{16\frac{1}{12}}} = 10$.   Hence $x = 1270\cdot4$ feet $= 423\frac{1}{2}$ yards $=$ the depth required.

The theorem at the top of the next page I cannot reduce to a proper form, nor diſcover what the author means by it; it is evidently nonſenſe as it ſtands, but I have printed it exactly as I found it.

But by Dr. Hally's numbers, let $a = 16$ foot 1 inch, $b = 1142$ feet the motion of found, $t =$ the time, x the depth; there will arise this theorem,

$$x = \frac{a\,b\,t \times \frac{1}{2}a}{b^2} \quad \frac{a}{2\,b\,b} \quad \sqrt{4\,b\,t \times 1} = 1265\cdot82 \text{ feet.}$$

N. B. The method taught in Lexicon Technicum, and several authors, to find a depth by the falling of heavy bodies, is false. The time the found is reaching the ear, must be deducted out of the latter part of the stone's falling. In that author's example, under the word pendulum, according to the time of the body's falling, the well is 256 foot deep; then he allows for the found's ascending $\frac{1}{7}$ of 16 foot to be subtracted, makes it just 250 feet: whereas in the last second, the stone fell 112 feet, therefore $\frac{1}{4}$ of that (at least) must be deducted, it will be but 225 feet.

The prize of 10 diaries fell to Mr. Christ. Mason *of London.*

Of the Eclipses in 1723.

1. Sun eclipsed, Thursday the 23d of May, a quarter past 3 in the morning, invisible.

2. Moon eclipsed, June the 7th, at 4 in the afternoon, invisible.

3. Sun eclipsed, November the 16th, 3 quarters past 9 at night, and invisible.*

New

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* This year, in the months of October, November, and December, a small new comet was observed by Mr. *Bradley*, Dr. *Halley*, and several others; from whose observations and calculations it appears that,

The inclination of its orbit and ecliptic was —	49° 59'	0″
The place of the ascending node — —	♈ 14 16	☉
The place of the perihelion — — —	♉ 12 52	2d
The distance of the perihelion from the node —	28 36	20
The log. of the perihelion distance — — —	9·999414	
The log. of the diurnal motion — — —	9·961007	

The equal time of its being in its perihelion Sept. 16 d. 16 h. 10 m. *In its orbit* thus situated, the motion of the comet was retrograde *or contrary to the order of the signs.*

New Paradoxes.

Par. 1. There is a certain noted place in the vaſt Atlantic ocean, where a briſk Levant is abſolutely the beſt wind for a ſhip that is to ſhape a due eaſt courſe, and yet ſhe ſhall ſtill go before it.

Par. 2. It may be clearly demonſtrated by the terreſtrial globe, that it is not above twenty-four hours ſailing from the river of Thames in England, to the city of Meſſina in Sicily, at a certain time of the year; provided there be a briſk north wind, a light frigate, and an azimuth compaſs.

Par. 3, *by Mr.* Richard Tapper.

A certain mount in Devonſhire doth ſtand,
Whoſe lofty head o'erlooks the neighb'ring land;
And ſuch is the known property o'th' hill,
That if a veſſel you with liquor fill
At the hill's top or vertex of this place,
It holds leſs than if filled at the baſe.
Now what's the cauſe of this deficiency,
Pray let me know in the next diary.

Par. 4, *by Mr.* Chriſt. Maſon.

When tyrant Noll, at fatal Worc'ſter fight,
His crew harangu'd, againſt both law and right;
His quaint numerique no two did hear,
Tho' ſev'ral thouſand miſcreants were there:
For ev'ry man, and ev'ry ſev'ral ear,
Did not the ſame, but different voices hear.

New Queſtions.

I. *Queſtion* 99, *by Mr.* C. Maſon.

Two ancient towns, for two true lovers fam'd,
Abydos one, the other Seſtus nam'd;
Thro' Abydos Leander's praiſes rung,
In Seſtus they of Hero's beauty ſung:
The Helleſpont thoſe noted towns did part,
But was no bounds to love's unerring dart:
When ſhe the greatneſs of her power diſplay'd,
And ſuch a wound at ſuch a diſtance made.

But

But cruel fate their free accefs deny'd,
And kept 'em pris'ners on each diftant fide.
She was confin'd like Danae in a tow'r,
Yet conquer'd was without a golden fhow'r:
He fo confin'd upon his native fhore,
No boats nor barges e'er durft waft him o'er.
Each had a view of the adjacent lands,
Plac'd oppofite upon the lonefome ftrands.
Tho' boift'rous furges did with envy roar,
And dafh with fury on the patient fhore;
His darling love wou'd no fuch bars allow,
But naked ftripp'd did on the billows plow:
With fpeed he cut his proud triumphant way,
As flutt'ring waves did round his body play.
   In equal times he equal fpaces ply'd,
Swift as the waves did o'er the channel glide;·
Each tow'ring wave the former did fuccced,
Juft forty foot rolling with equal fpeed.
If equidiftant from each place you were,.
And the obfervation angle fhou'd appear
Juft forty-three degrees; move t'wards 'em ftreight,.
Five furlongs juft, the angle's forty-eight.
The breadth o'th' Bofphorus I pray explore,
Likewife the time he fwam 'twixt fhore and fhore..

II. *Queftion* 100, *by Mr.* John Richards.

From Edyftone viewing the neighb'ring fhore,
And willing to know how far it is o'er,
To three ports within fight; their diftances are known,.
From each other, as here under I have fhown.
I thought the beft I cou'd do was to try,
Which way from the rock thofe three places lie;
This I have done, and it is noted here.
Pray what will the three diftances appear?

The diftance from ⎰ Plymouth to Lizard 60 ⎱ miles.
⎰ Lizard to Start Point 70 ⎱
⎰ Start Point to Plymouth 20 ⎱

Plymouth ⎱
Lizard   ⎱ bears from Edyftone rock ⎰ North.
Start Point ⎰   ⎰ W. S. W.
                               ⎰ E. b. N.

III. *Queftion*

III. *Queſtion* 101, *by* Mr. John Willingham.

One evening from a mountain high,
  Soon as the ſun was down,
Looking towards the eaſtern ſky,
  I ſaw the riſing moon;
Her diſtance from the zenith then,
  Streight way I did explore,
And found degrees fourſcore and ten,
  And fifty minutes more.
A tube inclining one degree,
  And minutes fifty-eight,
Thro' which a ſhip appear'd at ſea,
  Full crowding on my ſight:
The diſtance of that ſhip, o'th' main,
  In leagues I do require,
Likewiſe what height above the plain
  That mountain does aſpire.

IV. *Queſtion* 102, *by* Mr. John Simmons.

In maſon's yard there happened to roll
A pyramid's fruſtum into a plaſhy hole,   }
Whoſe baſes are (in form) octagonal.   }
The leſs baſe ſides juſt touch'd the water's brink,
The greater baſe did wholly in it ſink;
So that the level ſurface of the water
Did nicely cut (or very near the matter)
The fruſtum with a line diagonal.
Being thus immers'd, I cou'd not take all
Uſual dimenſions; which made me fret,   }
'Cauſe I each part's ſolidity muſt get,   }
Both of the dry, in inches, and the wet. }
To help me out a friend gave me a line,
That was divided in extream and mean:
The greater ſegment was the length o'th' ſide,
Leſs baſe's breadth the other;——he alſo ſaid,
That baſe and ſide an obtuſe angle making,
Of juſt fiveſcore degrees (when 'twas taken)
And this the fruſtum's whole ſolidity.   15882ı'64 }
I've loſt the line, and the taſk's too hard for me; }
Ladies—Pray ſolve the ſame in your next diary.   }

V. *Queſtion* 103, *by Mr.* Will Doidge.

Of you, fair ladies, I a favour fue,
'Tis your bright genius muſt refolve it too.
I in a garden have a piece of ground
In oval form, the tranfverfe I have found
Juſt fifteen feet, the conjugate was ten ;
An ordinate which cuts the tranfverfe length,
From off the center juſt three feet two-tenth;
Not rightly apply'd, but inclined laid,
And fev'nty-two degrees an angle made.
What length each part is from the tranfverfe axe,
Of you, bright wits, I with fubmiffion aſk.

VI. *Queſtion* 104, *by Mr.* Tho. Williams.

Wand'ring Æneas, long with tempeſts toſt,
Was thrown upon the famous Libyan coaſt,
Where mighty Carthage ſtood, and Dido queen,
Late come from Tyrus with her ſlender train.
This ſplendid town (a village late) they view,
Whilſt Tyrians do their daily taſk purfue,
And dig foundations for their building maſters,
Hewing out and making fine pilaſters.
One ſtone among the reſt was fixed there,
Of poliſh'd marble wrought, its bafe four-fquare;
Its curious ſhape was pyramidical,
: Its lofty height twice the diagonal :
And whilſt Æneas view'd this finiſh'd ſtone,
The mafon faid, Thou pious mighty ſon
Of old Anchyfes, by the foot 'twas made,
But being unmeafur'd, I am ſtill unpaid;
And muſt be fo, unlefs fome artiſt's ſkill,
More than my own, that taſk for me fulfil.
Its weight is juſt forty-eight tun complete ;
But how from thence to find its folid feet,
I know not; but defire that, aiding, you
Wou'd that and its dimenfions ſhew.

The Prize Queſtion.

When brilliant wits the ſplendid forms wou'd ſhew
Of niceſt architecture to our view ;
Nothing near home is worthy of their note,
But all's fetch'd from thofe kingdoms more remote.

Ro

Rome, Egypt, Italy, or ancient Greece,
Is art's as well as nature's master-piece;
Magnificent their turrets, pyramids
Rearing above the clouds their lofty heads:
Their putrid waters must be cryftalline,
Their common pebbles orient pearls out-fhine;
Their verdant meads from pinching frofts be free'd,
And never-fading blooms the trees o'erfpread.
    Thus the fantaftic humours of the age
Delight themfelves, and all their thoughts engage
To things of foreign growth, or antic mien,
Neglecting what's more eafy to be feen.
If from the heathen poets tales they tell,
It proves a modern proper vehicle,
To pafs the airy gilded phantom down,
Pall'd with more worthy objects of their own.
Strangely deprav'd fuch fleeting fancies are,
And like weak eyes diftinguifh nothing near
Without their optic glaffes; but from far
Miftake a lamp for Titan's rifing car.
    Yet ftately ftructures thus defcrib'd we prize,
And much relent we fhou'd thofe rules defpife
The Romans brought; and, in the Gothic way,
Without a rule or order, art difplay.
    But notwithftanding that, we may behold
Amongft us buildings beautiful and old;
Weftminfter Abbey, and St. Peter's, York,
King's College, Cambridge, admirable work;
And, tho' lefs fam'd, as juftly may admire,
Amongft the reft, that noble lofty fpire
To the Botoners honour built in Coventry,
Second to none in fprightly fymmetry,
Only o'er-top'd in height by Salifbury.
In ev'ry part it entertains the eye
With ftatuary work, and fine embroidery:
Yet full of ftrength and grandeur, that it feems
A geometric mean, 'twixt two extreams.
    And altho' mathematic inftruments
Furnifh with methods for its full extents;
I'll here propofe, from algebraic art,
And from a theorem Euclid does impart,
To find its height, without the help of thofe,
And freely tell the rule that I have chofe.
  " An ancient houfe there ftood in a low place,
  " Whofe top's exactly level with the bafe,
  " Or fteeple's bottom: then I take my ftand
  " A diftance off, but ftill on lower land;

" To th' houfe and fpire I my eye confine,
" And find it runs directly in a line;
" And diftant from the foot along the ground,
" Two hundred and eighty-two feet two-tenths is found; **282·2**
" The horizontal line, from the houfe-top muft be
" Juft the fame numbers you i'th' margin fee.*   * **228¼**
" That from my eye to th' top, I do declare,
" Added to th' higheft perpendicular,
" In feet thefe numbers will exactly give,
" Four cents, above feven hundred feventy-five.   **775·04**

1724.

Paradoxes anfwered.

Paradox 1 anfwer'd.

IF the place be eaftward of the Levant, a fhip may be car-
ried by an eaft wind round the globe to it; provided fome
eaft point be fix'd. *Ja. Wylde.* Or, where there is a violent
tide. *Oedipus Schaftienfis.* 'Tis meant the gulph of Florida.
J. Richards, T. Gill. But the quibble may lie in the word
fhape, for an eaft wind may be beft for carrying her out of
an harbour to fail to a place on the eaftern part of that ifland
or continent.

Par. 2. Is meant the artificial globe and the hand index.

Par. 3. Water has its furface always of a fpherical figure;
and that fartheft from the earth's center is leaft fwelling,
and confequently holds leaft above the brim of the veffel.

Par. 4. Sound being efflated in concentric circles, as a
ftone falling into water moves it all round, fo that part of a
circle which touch'd one man's ear, could not touch another's
who cou'd not be in the fame individual fpot of ground.

Queſtions anſwer'd.

* I. *The* 99*th* *Queſtion anſwer'd by* Mr. Rich. Tapper.

As the rectangle of the radius and the ſine of 2° 30′ : the rectangle of the ſines of 24° and 21° 30′ :: 3300 = 5 furlongs : half the breadth of the Boſphorus 11277·764613 feet. The whole breadth is 7515·1764 yards = 34 furlongs 35 yards = 4 miles 2 furl. 35 yards. Then (according to Sir Iſaac Newton) a wave runs thro' its breadth, whilſt a pendulum, whoſe length is equal to that breadth, oſcillates or vibrates once. A pendulum of 40 feet in length vibrates 17·14642817 times a minute. Conſequently he ſwam 685·85 feet per minute. From hence the time is 32′ 53″ 11‴ 52⁗.

The propoſer and ſome others give the anſwer 7518·7 yards, and the time 33 min. or 32·9039.

II. *Queſtion*

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* I. QUESTION 99.

If C and D repreſent the two places of obſervation, and AB half the breadth ·of the Boſphorus : then we have given all the angles and the line CD, to find AB; viz. ∠ C = 21° 30′ = half the firſt obſerved angle, ∠ BDA = 24° = half the latter, ∠ DAC = (∠D — ∠C=) 2° 30′, and CD = 5 furlongs = 3300 feet.——Hence, by common trigonometry,

   s. CAD : s. C :: CD : DA, and
   radius : s. D :: DA : AB; hence by compounding theſe two proportions, &c.
   radius × s. CAD : s. D × s. C :: CD : AB, that is
   radius × s. 2° 30′ : s. 24° × s. 21° 30′ :: 3300 feet : half the breadth of the Boſphorus, as in the original ſolution.

Again, by the nature of pendulums, $\sqrt{\frac{39\cdot2}{12}}$: $\sqrt{40}$ :: 1″ :

$\sqrt{\frac{40 \times 12}{39\cdot2}} = \frac{10\sqrt{6}}{7} = 3\frac{1}{2}$ ſeconds, very nearly, = the time in which a pendulum of 40 feet makes one vibration, or = the time in which the wave or the ſwimmer moves 40 feet. And, conſequently, as 40 feet : 3½″ :: the whole diſtance : time of ſwimming.
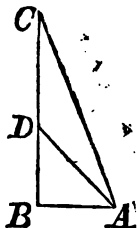
II. *Queſtion* 100 *anſwer'd by Mr.* John Topham.

This queſtion is to be found in Philoſophical Tranſactions, propoſed by Mr. Townley, with Mr. Collins's conſtructions to all its caſes. From Edyſtone to Lizard 53·112 miles, to Start Point 17·134, to Plymouth 14·187.

The queſtion being ſomewhat curious, I ſhall here give the method of ſolving it. Becauſe any two of the angles anſwering the rumbs given in the queſtion, exceed 180 degrees, the point where Edyſtone ſtands muſt fall within the triangle. Then if you ſuppoſe a circle to páſs thro' Lizard, Edyſtone, and Start, and biſect the line between Lizard and Start,

* II. Q U E S T I O N 100.

Another method of conſtruction and calculation may be thus.

Conſtruction.

With the three given diſtances, 60, 70, and 20, make the triangle *L P S,* wherein *P* will be Plymouth, *L* the Lizard, and *S* the Start. Then if *E* be ſuppoſed to repreſent the Edyſtone, the direction *E P* being North, *E S* being E. by N. and *E L* being W. S. W. there will be known all the angles about the point *E.* Hence, ſuppoſing *P E* produced to *A,* if on *L S* there be deſcribed the ſegment of a circle *L E S* to contain the given angle *L E S* = 15 points or 168° 45', and then there be made either the angle *S L A* = 9 points = ∠ *A E S,* or the angle *L S A* = 6 points = ∠ *A E L, L A* or *S A* cutting the circle in *A*; it is evident that *E* will be the point of interſection of *A P* with the circle.
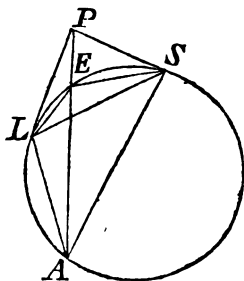
Calculation.

1. In the triangle *L P S,* are given all the ſides, and of conſequence the angle *P S L.*——2. In the triangle *A L S,* are given *L S,* the ∠ *A S L* (by conſtr.) and the ∠ *A* = the ſupplement of ∠ *L E S;* to find *S A.*——3. In the triangle *P S A,* are given *P S, S A,* and ∠ *S;* to find ∠ *P A S* = ∠ *S L E,* and ∠ *A P S.* ——4. In the triangle *L E S,* are given the angles and the ſide *L S; to find L E* and *E S.*——5. And, laſtly, in the triangle *P S E,* are given the angles and the ſide *S P ; to find P E.*

Start, producing fuch line through the center of that circle to the periphery, lines drawn from the point in the periphery to Lizard and Start, with the two lines from Edyftone to Lizard, and from Edyftone to Start, will be a trapezia infcrib'd in a circle, which according to 22 Euclid 3, the two oppofite angles taken together are equal to two right angles; confequently the angle at the periphery is 11° 15′, the complement to that at Edyftone 168° 45′ given. In like manner, let a circle pafs through Plymouth, Edyftone, and Lizard, the angle at the periphery will be 67° 30′, the complement to the other rumb given, 112° 30′. Again, if from the center of the firft circle you draw lines to Lizard and Start, the angle contain'd between them will be double to that at the circumference, by 20 prop. Euclid 3, viz. 22° 30′, and in the other circle 135°. Then,

s. 11° 15′ : log. of ½ 70 miles given :: radius : femi-diam. circle 179·4. Alfo,

s. 67° 30′ : log. of ½ 60 miles given :: radius : femi-diam. circle 32·47.

Now there is given the two femi-diameters of the circles, and the angle between them = 116·38, to find the angle fubtended by the leffer femi-diameter.

As fum fides : difference :: tang. ½ oppofite angles : tang. of ½ the difference of the angles; which angle is 8° 31′. Then radius : log. 179·3 :: s. 8° 31′ : log. of 26·52; which doubled is the diftance between Edyftone and Lizard 53·04 miles. For the other two, there are 2 fides, and an angle oppofite to one of them, given, to find the other fide. Hence from Edyftone to Plymouth is 14·333 miles, and from Edyftone to Start Point 17·36.

III. *Queſtion* 101 *anſwer'd by Mr.* Tapper.

As radius : the fecant of 50′ :: femi-diam. earth : the femi-diam. and height of the mountain in one fum. Sem. earth : s. 88° 2″ :: laft fum : s. angle oppofite 91° 47′. Confequently the angle at the center is known.

If the diameter of the earth be, as Norwood makes it 41899310 Englifh feet, the mountain's height will be = 2216·473 feet, the fhip's diftance 14·6288 miles, and from the bafe of the mountain on the arch of a great circle 12·726.

N. B. The propofer gives this anfwer, viz. The moun‑ tain's height 746 yards ¾, at 70 miles to a degree; the fhip's diftance 3 leagues 2 miles. But fome others, accord-

ing to the difference of miles to a degree, 881 yards and
5 leagues, &c.*

† IV. *Queſtion* 102 *anſwer'd by the ſame.*

Let $a = \cdot 82847$, the area of an octagon whoſe diameter is 1,
$C = $ content of the fruſtum, $s = $ fine 10°, $c = $ its coſine, $r = $
radius, $x = $ diameter of leſſer baſe, $y = $ the ſlant ſide of the
fruſtum more the leſſer baſe; then $axx = $ the area of leſſer
baſe, and the ſlant height $= y - x$. Therefore $y : y - x ::$
$y - x : x$ by the nature of the line.

And

The above original ſolution will be evident from this figure ; in
which C repreſents the center of the
earth, $A B$ the hill, S the ſhip, and
$A M$ a tangent to the earth directed to
the riſing moon. For, M being a right
angle, and $\angle A C M = $ 50', whoſe tan-
gent is $M A$ and ſecant $A C$, it will be as
radius : ſec. $\angle A C M :: C M : C A$.
—— Again, the $\angle S A C$ being $= 88°$
2', and the ſides $C S$, $C A$ known; we
thence find the third ſide $A S = $ the
diſtance of the ſhip from the top of the
mountain ; as alſo the $\angle S C A$, and
conſequently the arch $S B$ the diſtance
of the ſhip from the bottom of the
mountain.
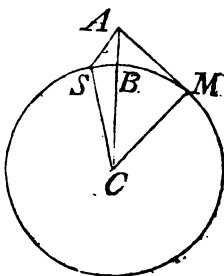
† IV. QUESTION 102.

The ſolution to this queſtion will perhaps appear a little clearer
thus.——The ſlant ſide being the greater part, and the diameter
of the circle inſcribed in the leſs end the leſs part of a line di-
vided in extreme and mean proportion ; the meaning of which
is, that the greater part is a mean proportional between the leſs
part and the whole, that is $xx = \overline{x + y} \times y = xy + yy$, put-
ting $x = $ the greater part or the ſlant height, and $y = $ the leſs or
the diameter of the circle in the leſs end. Now from this quadratic
equation is found $y = \dfrac{\sqrt{5} - 1}{2} x = ax$, putting $a = \dfrac{\sqrt{5} - 1}{2}$.

Now, the ſlant ſide making an angle of 100° with the leſs end,
or of 80° with the greater, put s and c for the ſine and coſine of
80° ; then sx will be the altitude of the ſolid, and cx the half dif-

ference

And $yy - 2yx + xx = yx$. Hence $y = 1.5 + \sqrt{\frac{1}{4}x}$.

And $y - x = .5 + \sqrt{\frac{1}{4}x} =$ the flant fide.

As radius : $.5 + \sqrt{\frac{1}{4}x} :: s : \dfrac{.3s + s\sqrt{\frac{1}{4}x}}{r} =$ the half dif-

ference of the breadths of the two bafes. And confequently

$1 + \dfrac{s + 2s\sqrt{\frac{1}{4}x}}{r} =$ the breadth of the greater bafe $= bx$.

Then the area of the greateft bafe $= abbxx$, and the geo-
metrical mean area $= abxx$.   Then

As radius : $.5 + \sqrt{\frac{1}{4}x} :: c : \dfrac{.5c + c\sqrt{\frac{1}{4}x}}{r} =$ the altitude of

the fruftum $= dx$.   And by multiplication we have

$\frac{1}{3} adx^3 \times \overline{bb + b + 1} = C = \frac{1}{3}$ of the three areas multiplied

by dx the height $= mxxx$.   And hence $x = \sqrt{\dfrac{C}{m}} =$

41.633534 inches.   Then making the fquare root of the area
of the leffer bafe $= d$, the greater $= D$, the height $= H$.

		By J. Painter.
$DD + \dfrac{DDd}{D+d} \times \frac{1}{3}H = 107707.75$ the wet part.		107784.57
$dd + \dfrac{ddD}{D+d} \times \frac{1}{3}H = 51113.89$ the dry part.		51637.07
Breadth of leffer bafe — —	41.6335	41.6641
Side of leffer bafe — — —	17.2451	17.2530
Breadth ⎫ of greater bafe — ⎧	65.0286	65.0720
Side ⎭ ⎩	26.9357	26.9524
Altitude — — — —	66.3410	66.3290
Slant height — — —	67.3674	67.4040
Area of ⎧ leffer bafe — — ⎩ greater bafe — —	1435.959½ / 3503.2256	1437.66 / 3507.19

V. *Queftion*

ference between the diameters of the two ends; and confequently
$y + 2cx$ or $ax + 2cx =$ the diameter of the circle in the greater
end $= bx$, putting $b = a + 2c$.——Then, putting n for the
area of the octagon, the diameter of whofe infcribed circle is 1,
we fhall have $na^2 x^2$ and $nb^2 x^2$ for the areas of the two ends,
and $nabx^2$ their mean proportional; hence the content will be

$sx \times \dfrac{na^2 x^2 + nabx^2 + nb^2 x^2}{3} = 158821.64 = d$, from

which is found $x = \sqrt[3]{\dfrac{3d}{ns \times \overline{aa + ab + bb}}}$.   Confequently all

the parts become known, and thence the content of each hoof as in
the original folution.   Y 3

* V. *Queſtion* 103 *anſwer'd by Mr.* J. Painter.

The length of the greater part of the ordinate 5·18, and
the leſſer 4·23.

By Mr. *Tapper*, 5·13416 and 4·20625.

† VI. *Queſtion* 104 *anſwer'd:*

A cubic inch of marble weighs 1·56185 ounces avoirdupois,
ſo the content of the pyramid is 634·5729257 ſolid feet. The
proportion of the ſide of a ſquare to its diagonal, is as 1 to
1·4142. Multiply the ſolid content by 3, and divide the pro-
duct by 2, gives 952·782, which multiplied by the ſquare of
1·4142 = 1·99936, gives 1906, whoſe cube root is 12·319,
the diagonal. Divide 952·78 by 12·31, gives 76·89, whoſe
ſquare root 8·768 is the ſide of the ſquare ſought.

The

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* V. QUESTION 103.

Let $D\,D$ be the line cutting the tranſverſe $A\,B$ in an angle of
72 degrees at the point E; draw
the perpendiculars $D\,F$.

Put $m =$ ſemi-tranſverſe, $n =$
ſemi-conjugate, $a = CE$, s and
$c =$ ſine and coſine $\angle E =$
72°, and $x = DE$.——Then
$DF = sx$, $EF = cx$, and CF
$= a \pm cx$; hence, by the na-
ture of the ellipſe, $m^2 : n^2 ::$
$\overline{m + a \pm cx} \times \overline{m - a \mp cx}$:

$s^2 x^2 = n^2 \times \dfrac{\overline{m^2 - a \pm cx}^2}{m\,n}$; this equation reduced becomes

$xx \pm ·9282248 x = 21·5945$; hence $x = 4·206$ or $5·1342 =$
the two parts required.
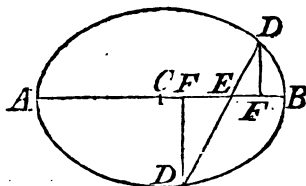
† VI. QUESTION 104.

The content being found as in the original ſolution above, put
it $= c$, and $x =$ the ſide of the ſquare baſe. Then $xx =$ the area
of the baſe, $x\sqrt{2} =$ the diagonal, and $2x\sqrt{2} =$ the height.

Hence the content $\dfrac{2 x^3 \sqrt{2}}{3} = c$; then $x = \sqrt[3]{\dfrac{3 c}{2\sqrt{2}}} =$ the ſide

of the baſe, and $(2 x \sqrt{2} =) \sqrt[3]{24 c} = 2\sqrt[3]{3 c} =$ the height.

* *The Prize· Queſtion. anſwer'd by* J. Painter.

Put $CA + CD = 775\cdot04 = s,$

$AD = 282\cdot2 = d, \quad AB = 228\cdot75 = b;$

Subſtitute $2x = ss - dd,$

Which by the procefs in Ward's Math. Guide, p. 336, at the 21ſt ſtep, you will have
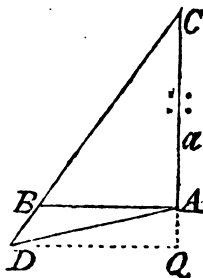
$$\frac{ssaa - 23a^3 + a^4}{bb + aa} = \frac{xx - 2xsa + 2xaa + ssaa - 2sa^3 + a^4}{aa}.$$

Which

The procefs for finding the equation in the above original folution, may be thus :

Put $s = AC + CD$, $b = AB$, $d = AD$, and $z = AC$ the height of the ſteeple; then $s - z = CD$. Draw DQ perpendicular to CA produced in Q.——Now, by right-angled triangles, $BC = \sqrt{bb + zz}$; and, by fimilar triangles, $CB : \overline{CD}$

$$:: \left\{ \begin{array}{l} CA : CQ = \dfrac{s-z}{\sqrt{bb+zz}}z \\[2mm] AB : QD = \dfrac{s-z}{\sqrt{bb+zz}}b \end{array} \right\} ; \text{ hence } QA = QC - CA$$

$= \dfrac{s-z}{\sqrt{bb+zz}}z - z$; and then, by right-angled triangles again, $dd = AQ^2 + QD^2$, which equation reduced, and $2aa$ written for $ss - dd$, we have

$$\left. \begin{array}{c} +2a^2 \\ +b^2 \end{array} \right\} z^4 \left. \begin{array}{c} -2a^2s \\ -2b^2s \end{array} \right\} z^3 \left. \begin{array}{c} +a^4 \\ +2a^2b^2 \\ +b^2s^2 \end{array} \right\} z^2 - 2a^2b^2sz = $$

a^4b^2, which is the equation required.

Which being reduced by multiplication and tranfpofition, will ftand, $- bba^4 - 2xa^4 + 2sbba^3 + 2xsa^3 - 2bbxaa - bbsaa - xxaa + 2bbxsa = xxb\dot{b}$. In numbers, $- 573376\cdot72\,a^4 + 484945075\cdot246\,a^3 - 126569950746\cdot798\,aa + 21131282571666\cdot926\,a = 3551576300531368\cdot689$. If the terms be divided, it will ftand, $- a^4 + 845\cdot77\,a^3 - 220744\cdot848\,aa + 3685411\cdot9\,a = \dot{6}192379528\cdot849$.

From hence will be found a the height of the fteeple $= 310\cdot8409$ feet.

But if there had not happen'd a miftake in the laft line in printing the queftion, which fhould be $755\cdot04$, the anfwer had been 300 feet, the true height of Coventry fpire, as I actually meafur'd it both by lines and inftruments, Sept. 26, 1721.

A Letter to the Author.

S I R,

I have oftentimes thought the compofition of the enigmas and queftions might be improved, and was therefore mightily pleafed to fee in your laft year's diary fuch ufeful and neceffary hints for the compofing a proper enigma. But I have often privately complain'd that arithmetical queftions have been very dubious and unintelligible; and therefore could wifh fome neceffary directions were laid down, to guide perfons of a good mathematical genius to a proper way of diverting their thoughts upon fuch occafions. And,

1. The moft natural method in anfwering the queftions, fhould be a little regarded in the compofition.

2. No queftion that can be anfwer'd two ways fhould be allowed of, which will neceffarily lead fome from the expected anfwer.

3. Nothing that is very paradoxical, much lefs naturally impoffible, and void of demonftration, fhould be put for an arithmetical queftion.

4. No ambiguous or doubtful words fhould be ufed, but fuch as are plain and eafy to be underftood.

5. We fhould ufe the fame terms of art with the late and beft authors; or at leaft our terms and phrafes fhould be fo plain and eafy, as that none may be miftaken or deceived by them: for I think it is much better and more improving, to invent fomething ingenious than abftrufe. Nor do I fee any great benefit or difficulty in puzzling mankind, and racking their brains; nor is it neceffary, when there is fuch an infinite variety in the mathematics of pleafant and profitable propofitions. All kind of learning is difficult enough, efpecially the mathematical, to take up the fhort interims of our time, without being made more tedious and laborious; therefore we fhould make it our chief aim to facilitate and abridge it.

<div align="right">T. FLETCHER.</div>

Of the Eclipfes in 1724.

1. Moon eclipfed, Monday, April 27, 8 morn. invifible.

2. Sun eclipfed on Monday the 11th of May, at half an hour after 6 in the evening, almoft total, and vifible. This will be the greateft eclipfe that will happen in England for thefe 50 years.

The general eclipfe (in refpect to the meridian of London) begins at 52 minutes paft 2; the central fhadow enters on the earth in lat. 13° 56', in long. 226° 46'; whence it proceeds with a velocity of about 40 miles in a minute northeaftwards, along the weft fea, and over California, Nova Granada, and the northern parts of America, toward Terra Arctica, and Hudfon's Bay, where it tends towards the eaft, and paffeth Terra Cunadenfis, by Nova Francia, the Gulph of St. Laurence to Newfoundland; then traverfes the north fea to Europe, enters France about St. Malo, and proceeds along by Le Mans Blois, Bourges, and Challon-fur-foane, and having pafs'd through the north parts of Italy, by Geneva, and borders of Switzerland, over the Alps, by Palanza, Como, and Brefcia, it leaves the earth between Mantua and Rovigo.

<div align="right">*J. Willingham.*</div>

Mr. *Joseph Smith*, of Fleet in Lincolnshire, from a geometrical construction and a calculation, sends the following account of the sun's eclipse at Holbeach: begins 5 h. 41′, mid. 6 h. 37′, end 7 h. 29′. At Stockholm in Sweden, begin 6 h. 51′, mid. 7 h. 42′, ends 8 h. 27′. Digits eclipsed 8 12 south. At Bermudas in the West Indies, begin. 12 h. 43′, mid. 1 h. 43′, ends 2 h. 33′. Digits 3 north.

In lat. 2° 48′ north long. 132° 30′ west, at 5 h. 55′, the eclipse will begin at the sun's rising. Lat. 13° 50′ north long. 151° 18′ west from Holbeach, in the south sea, the sun will be centrally eclipsed as he riseth.

Lat. 51° 48′ north long. 89° 47′ west, at 11 h. 19′, the sun will be centrally eclipsed in the 90th degree at Canada, or New France in America.

In lat. 54° 19′ long. 82° 47′, part of Hudson's Bay, the sun will be centrally eclipsed in the meridian.

In the lat. 45° 16′ long. 11° 50′, parts of Mantua in Italy, the central eclipse will end. In lat. 34° 48′ north long. 10° 31′ west, the Atlantic ocean near Gibraltar, the eclipse 'ends.

☉ Eclip. 11 May, 1724, even.		Beg.	Mid.	End	Dig.	
		h.				
By Astron. Carol.	Coventry	V 38	VI 34	VII 26½	XI	31
Mr. Chattock {	London	5 39	6 36	7 23	12	7
	Coventry	V 32	6 29	7 23	12	0
Dr. Halley	London	5 39	VI 35½	VII 27½	—	—
Mr. Richards	Exeter	5 25	6 18	7 11	12	2
Mr Smith	Holbeach	5 41	6 37	7 29	11	30
. . . .	London	5 38	6 35	7 29	11	47
Mr. Willingham	Myton York	5 36	6 30	7 22	11	5
Mr. Gill	Worcester	5 31	6 27	7 20	11	51
Mr. Child	Northampt.	5 40	6 36	7 28	11	30
Mr. Williams	Oxon	5 35	6 31	7 23	—	—
Mr. Warner	Wellingbor.	5 39	6 36	7 29	11	37
Mr. Leadbetter	London	5 39	6 36	7 25	11	45

This eclipse will not be total, but at the greatest darkness there will be a small thread of light on the upper part of the sun's body, just a 24th part of his diameter or breadth. But some of the stars will be discern'd. The planets ♂ in the *south-east*, ♄ nearer the south, and ☿ on the left-hand, the *sun a little* higher.

3. Moon

3. Moon eclipfed, October the 21ft in the morning.*

	h. .,	Leadb.	J. Paint.
Beginning by Adraftea's calcul.	II 30	2 52	2 33
The middle at — —	III 47	4 8	3 52
The end at — — —	V 4	5 24	5 16
Digits eclipfed north ——	7 16	7 4	6 12

4. Sun eclipfed, November 4, at 11 at night, invifible.

New

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* This eclipfe was obferved thus :

1. At *Gomroon* in *Perfia* by Mr. *W. Sanderfon.*

The moon entered into the dark fhadow or umbra of the earth at 11 min. 33 fec. paft five, Ante Meridiem.

2. At *Rome* by *Blanchini.*

Temp. Var.
h. m. s.
3 15 40 Initium umbræ veræ.
5 48 50 Finis umbræ veræ.

3. At *Lifbon* by *John Baptifta Carbone*, and *Dominico Capaffo.*

Temp. Ver.
h. m. s.
1 38 0 Penumbra incipit effe fenfibilis.
1 47 45 Umbra incipit.
4 20 36 Finis eclipfis.
4 28 0 Definit penumbra fpiffior.

4. Other obfervations in *Britain*, taken from the Diary for the next year (1725).

	Begin.	Midd.	End	Digits
		h. m.	h. m.	
At Wyken in Warwickfhire —	- -	6 31	7 28	11
By Mr. Lawry, Cornwall ——	- -	6 22	7 20	12
Mr. Tapper, Briftol, continued ⎱ in total darknefs 2¼ m. — ⎰	- -	6 28	- -	12
Mr. Child, Newport Pagnel —	5 40	6 35	- -	- -

New Queſtions.

I. *Queſtion* 105, *by Mr.* Williams.

When fam'd Europa's ſon, Minos the juſt,
Beſieg'd Megæra's tower with his hoſt,
Whoſe founding walls, moted around, did ſtand,
Erected by Apollo's ſacred hand.
This Niſus held, whoſe purple hair, 'tis ſaid,   ⎱
Contain'd their ſafety, till it was betray'd   ⎰
To Minos, by his daughter's am'rous aid.
For whilſt ſhe view'd his practis'd chivalry
From off the tower, ſhe trembling thus did ſay:
" Inforc'd by love, this tower I intend,
" To render up, and give theſe wars an end.
" Did not Petrea's daughter, with like flame,
" Venture like hazards for Amphitryo's name?
" Then why ſhould Scylla leſs advent'rous prove?
" Love conquers all things; all muſt yield to love."
This ſaid (Pallas aſſiſting her) ſhe made
Of ropes a ladder, and by Cupid's aid
Convey'd it to her love upon the ſhore,
Who it aſcends, and ſo he gain'd the tower.
Now you'll expect, ſince I'm hiſtorian grown,
The tower's height; and that may thus be known:
For if 'tis multiply'd by * ninety-three,   * 93 feet
The breadth o'th' moat, and the product added be
To twice the ladder's length, 'twill make theſe feet,
Fourteen thouſand four hundred twenty-three, compleat.
                                                            [14423

II. *Queſtion* 106, *by Mr.* John Richards.

Being taking a glaſs with ſome friends of the town,
The exciſeman came in, whom we aſk'd to ſit down;
He did ſo, and as we did freely converſe,
Our new friend began the following diſcourſe.
" That ſpheroidal caſk (ſays he) on that ſtiller,
" Is more artfully made than any i'th' cellar;
" For whether you work by Mr. Oughtred's canon,
" Or multiply the difference by ſeven-tenths (as is common
" For us gaugers, when haſty, to do in the caſe)
" 'Twill bring out the ſame equal cylinder's baſe.
" *The* length of the caſk's forty inches five-tenths,
" *And* ninety-eight gallons I make the contents."
                                                            The

The veſſel lay level, the bung being up,
The liquor was eleven inches deep from the top.
I aſk'd if he knew how to ullage the caſk,
Alack, ſir, ſays he, that's no very hard taſk.
I queſtion'd his ſkill; this nettled the gauger,
Who preſently offer'd to lay me a wager,
That he'd tell to a ſpoonful the liquor's content:
'Tis done, ſir, (ſays I) for a crown to be ſpent.
He conſulted ſuch authors as merit regard,
For the ullaging part; as Hunt, Jones, and Ward.
And having gone thro' with the whole operation;
I found none of his methods would bear demonſtration:
So demanding the crown, he refuſes to pay,
Till I ſhew him a more mathematical way.
Now for ſake of the gains, I'd ſoon do't if I could,
But ſeeing I cannot, I beg that you would.

III. *Queſtion* 107, *by* Mr. A. Naughley.

Fair ladies, of you I muſt yet enquire
How the poll ſtood for the knights of our ſhire.
The number of voices, as I have ſeen,
Was five thouſand two hundred and nineteen.
Which among four was juſt ſo divided,
As one the ſecond and third exceeded
By twenty-two and fourſcore bating ſeven,
The fourth by no more than ſixſcore and ten:
Then how many votes had each candidate;
You can't in finding much trouble your pate,
But yet I'd have a general rule for that. }

IV. *Queſtion* 108, *by* Mr. Richard Whitehead.

Suppoſe four brothers repreſented be
By theſe four letters, *A*, *B*, *C*, and *D*;
And each of them unequally to ſhare   *perches*
A right-lin'd field, in form triangular; $65\frac{1}{2}$
Two ſhorteſt ſides of which the page does ſhow, $52\frac{89}{555}$
But for its baſe, it's what I do not know.
An oblong does poſſeſs the middle ſpace,
Touch'd by two ſides, and lying on the baſe,
Whoſe length in perches is in margin ſeen, $46\frac{272}{555}$
And its breadth, or height, is juſt eighteen:
The other ſhares do in each angle lie,
And their contents are what you're to deſcry.
  Diary Mathem.   Z   C takes

C takes the oblong, being the greateſt ſpace ;
B takes the angle oppoſite the baſe ;
A's on the left, *D*'s on the right does fall ;
He being youngeſt, had the leaſt of all.
I, who have ever loving prov'd and true,
Do for your anſwer, ladies, humbly ſue.

V. *Queſtion* 109, *by Mr.* Wm. Doidge.

One ſummer evening, as I walk'd alone,
I heard a damſel making piteous moan :
I aſk'd this fair the cauſe of ſo much grief,
If I cou'd give her troubled mind relief.
With ſighs and tears ſhe did her caſe explain ;
' Oh ! cruel love's the cauſe of all my pain.
' A ſpark, in whom external beauty ſhin'd,
' Hath won my heart, hath ſtole away my mind :
' That we ſhou'd wed my father gave conſent ;
' To live in joys and pleaſures permanent.
' But ah ! that happy day it muſt not be,
' Till this equation * and my age agree.
' All ways we've try'd, but all our labour's vain, ·
' To know my age, and cure me of my pain.
' ' Ceaſe, ceaſe, fair maid, your mournful tears, (ſaid I)
' To the ingenious ladies I'll apply,
' Whoſe ſkill in figures' ſeen i'th' diary.'
    Ladies, conſider love's tormenting pain,
Leave not this fair one longer to complain :
Tell her what age ſhe will be made a bride,
When ſhe'll be happy by her lover's ſide.

$$* \; \frac{\sqrt[2]{aaa} - \sqrt[3]{aa}}{4 \cdot 962} = a = \text{her age.}$$

VI. *Queſtion* 110, *by Mr.* George Brown.

Upon the northern ſeas, where boiſt'rous ſtorms did riſe,
And darkſome clouds obſcur'd the azure ſkies,
And from our ſight all its celeſtial bodies ſkreen,
That day or night to us could not be ſeen.
During which time, our gallant ſhip was toſs'd
'Midſt rocks and ſands, each minute caſt for loſt,
Where every billow did preſent a grave,
And death triumphant rode on ev'ry wave.
When in the height of ſorrow, fear, or doubt,
The ſtorm allay'd ; and to our joy bright Sol look'd out ;

Whoſe

Whofe altitude was taken in the heav'n,
And prov'd thirty-nine degrees, and minutes fev'n.
The calm continu'd, and in that very place
We ftay'd an hour and fifty minutes fpace;
And then bright Phœbus fmil'd on us once more,
His altitude again we did explore.   55° 57″
By our accounts, we found that very day
Fell out exactly on the tenth of May.
    Now, ladies fair, whofe wits are ripe at will,
In this diftrefs, I pray exert your fkill;
And from what here is found, gave me, I pray,
The latitude o'th' fhip, and hours o'th' day.

The Prize Queſtion, by Adraſtea.

    When poets feign Atlas the world cou'd bear,
And giant great Goliah wield the fpear:
Prodigious bulk! And Archimedes move,
With his machine, the lofty feat of Jove.
We ftand amaz'd, when they fuch things rehearfe,
About the vaft expanfe o'th' univerfe.
    Geographers do little lefs pretend
The faults and errors in the globe to mend:
Will all its parts, feas, creeks, and bays unravel,
Tho' they no farther than their garrets travel.
    I only have one county meafur'd over,
It's hard enough all parts for to difcover;
With curious theorms by old Euclid fhown,
And inftruments as heretofore unknown.
    At the interfection of two Roman ways,
Cut thro' this kingdom in their Cæfars days,
And by them nam'd the Watling-ftreet and Foffe;
There ftood Bennones, which now we call High Crofs.
From thence (nearly) in a ftraight line I come
Unto Dove Bridge, or fam'd Tripontium;
Bearing almoft fouth eaft by fouth: The whole
Was juft eight mile, one furlong, and five pole.
To Eathorpe I perambulating go,
The line is perpendicular I know;
But turns and windings, till the Foffe I met,
Will not its horizontal diftance get.
In a ftraight line the Foffe I meafur'd, till
I reach'd a tumulus call'd Brinklow-hill:
Defigning once again High Crofs to view,
And by my clock-work found I'd meafur'd true,
Eight miles, feven furlongs, and poles twenty-two: }

Tripontium then was juſt within my ſight,
A line drawn to it made an angle right:
With this perpend. and what before I've ſhown,
The triangle compleatly may be known.
　From Tripontium the river Avon I ſurvey'd,
Which many curious turns and windings made.
Cloſe by ſtands Newbold, eminently high,
Whence thoſe three places mention'd I cou'd ſpy:
'Twixt firſt and ſecond, the angles eighty-eight,
Fifteen : Eathorpe from the bridge call'd Dove,　88⁰ 15ᵉ
One hundred forty-nine, and forty-five did prove. 149　45
From Eathorpe to Bennones, of conſequence　·
One hundred twenty-two degrees : From hence　122　●
I cou'd adjuſt the diſtance to each place,
And tell if Avon truly meaſur'd was.
　This to Geodeſian's ſeldom known ;
Now tell the theorems by which they're ſhown.

1725.

Queſtions anſwer'd.

* I. Queſtion 105 anſwer'd by Mr. John Painter.

LET $b = 93$, $c =$ ladder's length, $a =$ tower's height. Then is $ab + 2c = 14423$ per queſtion, and $aa + bb = cc$, 47 Euc. 1. There will ariſe this ambiguous equation $a = \frac{1}{2}d + \sqrt{\frac{1}{4}dd - z} = 151\cdot2688$ the tower's height ; and the ladder's length $= 177\cdot57$.

II. *Queſtion*

* I. QUESTION 105.

　The ladder being the hypothenuſe of a right-angled triangle, whoſe baſe is the breadth of the mote, and perpendicular the height of the tower ; if b be put $= 93$ the breadth of the mote, and $x =$ the height of the tower, we ſhall have $\sqrt{b^2 + x^2} =$ the ladder ; and then $bx + 2\sqrt{b^2 + x^2} = 14423 = c$ by the queſtion ; which equation being reduced and a put $= b^2 - 4$, we have $x = \dfrac{bc - 2\sqrt{ab^2 + c^2}}{a}$.

* II. *Queſtion* 106 *anſwer'd by Mr.* John Knipe.

The bung diam. 32·1152 } inches for { 29·c66 } inches for
The head diam. 23·3168 } ale gall. { 21·103 } wine gall.
The ullage wine gall. $\begin{cases} 32·672 \\ 65·327 \end{cases}$ Ale gall. $\begin{cases} 28·018 \text{ dry.} \\ 69·981 \text{ wet.} \end{cases}$

The ſame anſwer'd by Mr. Rich. Tapper.

Let $H =$ the head diameter, $B =$ bung, D the difference $B - H$. By Mr. Oughtred's theorem $\sqrt{\dfrac{2BB + HH}{3}} =$ the diameter of an equal cylinder.

But

---

* II. QUESTION 106.

Putting b and h for the bung and head diameters; by Oughtred's rule $\sqrt{\dfrac{2b^2 + h^2}{3}} =$ the mean diameter $=$ (by the other method mentioned in the queſtion) $\dfrac{b - h}{10} \times 7 + h = \dfrac{7b + 3h}{10}$; from this equation is found $h = \dfrac{53}{73}b$; that is the bung and head diameters are exactly in proportion as 73 to 53.——Now let $73z$ and $53z$ be the two diameters; then, ſuppoſing the content 98 ale gallons, $\dfrac{2 \times \overline{73z}\,^2 + \overline{53z}\,^2}{1077·157} \times 40·5 = 98$; hence $z = \sqrt{\dfrac{98 \times 1077·157}{40·5 \times 2·73^2 + 53^2}} = ·4399361$, and conſequently the two diameters $73z$ and $53z$ are 32·11535 and 23·31662.

Then for the ullage of the caſk, it may be *truly* found by the rule in Cor. 2 page 290 Menſuration. Or, to uſe the approximating rule given at page 545 of the ſame, $\dfrac{11}{32·11535} = ·3425155$; the circular ſegment anſwering to this quotient is ·23785866; then ·23785866 $\times \dfrac{98}{·7854} = 29·68$ gallons $=$ the ullage nearly.

But, $\cdot 7 B + \cdot 3 H =$ the diameter of the equal cylinder per queſtion; by involution, tranſpoſition, and diviſion, we have

$$BB - \frac{126}{53} HB = - \frac{73}{53} HH, \text{ and } HH - \frac{126}{73} HB =$$

$$- \frac{53}{73} BB. \text{ Hence } B = \frac{73}{53} H; \text{ and } H = \frac{53}{73} B.$$

Wherefore it will be as $53 : 73 :: H : B$, and the contrary, univerſally: and the diameters 21·103 and 29·066 for wine gallons, or 23·316 and 32·115 for ale.

Let $x = \frac{1}{2}$ difference of the wet and dry inches, $b = \frac{1}{2}$ bung diameter. Then $2\sqrt{bb - xx} =$ the breadth of the ſurface of the liquor in the middle of the caſk; and multiplying by x, the fluent will be $2 b x - \frac{x^3}{3 b} - \frac{x^5}{20 b^3} - \frac{x^7}{56 b^5} - \frac{5 x^9}{576 b^7}$ — &c. = the area of the middle ſegment of a circle to the radius b, and the chord lines diſtance from the center in the bung diameter x.

Now to find the length of the radius at any diſtance from the bung diameter:

Let $a = \frac{1}{2}$ length of the ſpheroid, $l = \frac{1}{2}$ length of the caſk, $h =$ head diameter. Then $a a : b b :: \overline{a + l} \times \overline{a - l}$ $(a a - l l) : h h$, hence $a a h h = a a b b - l l b b$; put $c = b b - h h$, then $a a = \frac{l l b b}{c}$. Let $z =$ the diſtance of the circle from the bung diameter whoſe radius is ſought. Then $\frac{l l b b}{c}$: $b b :: \frac{l l b b - c z z}{c} : \frac{l l b b - c z z}{l l} =$ the ſquare of the radius; which rais'd to the $\frac{1}{2}$ power, it will give the radius $=$ $b - \frac{c z z}{2 b l l} - \frac{c c z^4}{8 b^3 l^4} - \frac{c c c z^6}{16 b^5 l^6} - \frac{5 c^4 z^8}{128 b^7 l^8} - \frac{7 c^5 z^{10}}{256 b^9 l^{10}}$ &c. which rais'd to its ſeveral powers, and ſubſtituted in the room of b, it will give the area. The ſeries multiplied by the fluxion of z, gives the ſolidity or quantity of liquor. Then find the fluent of each term, and let $l = z$, the ſeries will ſhew $\frac{1}{4}$ of the difference of the wet and dry parts; or, if $l =$ the whole length, gives the $\frac{1}{4}$ difference; which added or ſubtracted with the contents, ſhews the quantity of liquor in the caſk, 65·5541 vacuity, 32·4458 wine gallons.

* III. *Queſtion* 107 *anſwer'd by* Sylvia.

The ſum of any whole quantity and the exceſſes of its greateſt part above each of the other, being divided by the number of parts, gives the greateſt, and thereby all the other parts. Hence the firſt had 1361, the ſecond 1339, the third 1288, and fourth 1231 votes.

† IV. *Queſtion* 108 *anſwer'd by Mr.* A. Naughley.

Let $b = 65.5$ perches, $c = 52.16$, $d = 46.98$, $p = 18$; $a, e, o, u, y,$ = ſeveral ſegments of the lines in the triangle. Then $ee - yy = uu$, $aa - dd + 2dy - yy = uu$, $cc - 2ce + ee - oo = pp$, by 47 Euc. 1; $c : e :: b : a$, by 2 Euc. 6; and $o + y : c :: y : e$, by 4 Euc. 6: whence this equation $\dfrac{bb}{cc}ee - ee + \dfrac{2de}{c - e}\sqrt{cc - pp + ee - 2ce} = dd = 2077.9612$, which reduced and extracted, gives $e = 28.32$; conſequently $a = 35.36$, $o = 15.63$, $y = 18.56$, $u = 21.39$, and the whole baſe 86.539.

	A. R. P.			A. R. P.
A's ſhare =	1 1 16		C's ſhare =	5 1 5
B's —— =	3 0 20		D's —— =	0 3 21

V. *Queſtion*

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* III. QUESTION 107.

The rule mentioned in the original ſolution above, is thus diſcovered: Let the ſum s be divided into n parts, of which the differences between the greateſt and each of the reſt are $a, b, c, d,$ &c. Then if x be the greateſt, $x - a$, $x - b$, $x - c$, $x - d$, &c. will be the others; and their ſum $x + \overline{x - a} + \overline{x - b} + \overline{x - c} + \overline{x - d}$ &c. or $nx - a - b - c - d$ &c. $= s$; hence $nx = s + m$, putting m for the ſum of the differences, and $x = \dfrac{s + m}{n}$ = the greateſt; which is the rule.

† IV. QUESTION 108.

The original ſolution may be explained by this figure, in which $EFGD$ is the rectangle inſcribed in the propoſed triangle ABC, and BH perpendicular to AC; then the notation makes $b = AB$, $e = BC$, $d = FG$, and $p = EF$; alſo $a = FB$, $e = BG$, $o = DC$, $u = BI$, and $y = GI = DH$; and hence the equations and proportions in the ſolution are evident.
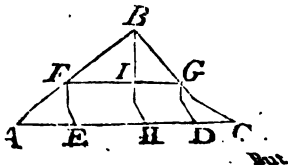
* V. *Queſtion* 109 *anſwer'd by* Mr. Tapper.

Given $a^{\frac{3}{x}} - a^{\frac{2}{3}} = 4.962 a = b a$ to find a. Let $x^6 =$ a; then $x^{18} = a a a$, and $x^{12} = a a$, alſo $x^{\frac{18}{x}} - x^{\frac{12}{3}} =$ $b x^6$, which when contracted is $x^9 - x^4 = b x^6$, and by tranſpoſition and diviſion $x^5 - b x^2 = 1$. Here x will be found $= 1.7425615449 +$, and $x^6 = a = 27.9981125 =$ 27 years, 364 days, 13 hours and $\frac{1}{4}$ *fere*, or 28 years *proxime.*

† VI. *Queſtion* 110 *anſwer'd by* Mr. Nat. Browne.

The latitude 46° 33′, the hours 8 h. 44 m. and 10 h. 15 m.

The

- But the ſolution will be ſimpler thus : Put b, c, d, and p for AB, BC, FG, and GD reſpectively, as in the original ſolution; and $\frac{AB}{BF} = \frac{BC}{BG} = \frac{AC}{FG} = x$: and hence $dx = AC$, and $BG = \frac{c}{x}$.

Then $dx : b + c :: b - c : \frac{bb - cc}{dx} = AH - HC$; hence $CH = \frac{dx}{2} - \frac{bb - cc}{2 dx} = \frac{ddxx - bb + cc}{2 dx}$; and then $BH^2 =$ $BC^2 - CH^2 = c^2 - \overline{\frac{ddxx - bb + cc}{2 dx}}\Big|^2 = \frac{4 b^2 c^2 - \overline{d^2 x^2 - m^2}\cdot^2}{4 d^2 x^2}$,

by putting m^2 for $b^2 + c^2$. Again, $CG : GD :: CB : BH$ $= \frac{px}{x - 1}$. Conſequently $\frac{4 b^2 c^2 - \overline{d^2 x^2 - m^2}\big|^2}{4 d^2 . x^2} = \overline{\frac{px}{x - 1}}\Big|^2$;

from which equation x is found $= 1.85$ nearly, and hence the other quantities all become known.

† VI. QUESTION 110.

Here are given two obſerved altitudes of the ſun (ſuppoſed to be freed from the errors of refraction), with the (ſuppoſed) true interval of time between the obſervations, as alſo the declination of the ſun ; to find the latitude and true times of obſervation. It is admitted that the watch or time-keeper may be too faſt or too ſlow, but yet however it is ſuppoſed to go true for the interval of time between the obſervations. The declination for the ſuppoſed middle true time between the times of obſervation, may be uſed for the common declination at both times, unleſs the interval of time be great; but if this be thought not ſufficiently accurate, let the declinations be taken for the two ſuppoſed true times themſelves, and uſed in the calculation.

The Prize Question answer'd.

In the first part of the question there is given in a right-angled triangle ABC, the cathetus AB, and the alternate segment of the hypothenuse CD, (made by a perpendicular BD, let fall from the right angle;) to find the other segment DA. Put $c = AB$, $b = CD$, and there will arise this theorem, $a = \sqrt{cc + \frac{1}{4}bb} - \frac{1}{2}b = 4\cdot81903$, and by 47 Euc. 1, the base $= 11\cdot0836$, the perpendicular $DB = 6\cdot55$; which compleats the triangle.
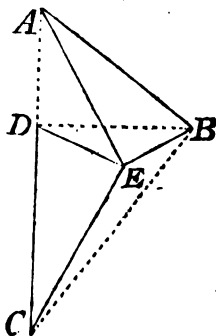
Then

Construction.

On a proper plane, as a primitive, describe the triangle $OP\odot$, making $\odot P$, OP equal to the co-declinations for the two times, and the angle at P equal to the given interval of time; then will P be the pole, and $\odot$, O the places of the sun at the first and second observations. Again, about the poles $\odot$, O describe two circles at the distance of the two observed co-altitudes and interfecting in Z the zenith of the place. Then a great circle described through P, Z will be the meridian, the arc $PZ =$ the co-latitude, and the angles $ZP\odot$, ZPO the measures of the times required.
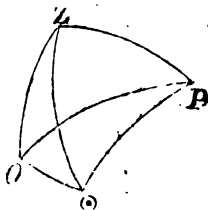
Calculation.

Drawing the great circles ZO, $Z\odot$. In the triangle $OP\odot$ are given the two sides OP, $\odot P$ equal the two co-declinations, and the included $\angle OP\odot =$ the interval of time; to find $O\odot$ and and the $\angle O\odot P$. Then in the triangle $OZ\odot$, are known the three sides; to find the $\angle O\odot Z$; which taken from the $\angle O\odot P$, there remains the $\angle Z\odot P$. Lastly, in the triangle $Z\odot P$, are known the two sides $Z\odot$, $\odot P$, and included $\angle Z\odot P$; to find the side PZ the latitude, and the $\angle ZP\odot$ the time for the first observation from noon; from which taking the given difference $OP\odot$, there remains the time of the second observation from noon.

Then from E where Newbold ftands, there is given the angle AEB 88° 15'; BEC 149° 45'; and CEA 122°. To find the diftances EA, EB, EC, and ED. And here we muft note, as in the anfwer to queftion 100, that as any two of the angles given, together exceed 180 degrees, the point where Newbold ftands will fall within the triangle ABC.

Now if you fuppofe a circle to pafs through C Eathorpe, E Newbold and B Tripontium, and bifeĉt the line CB, producing that bifeĉtion through the center of the circle, it will cut the periphery in a point, from whence lines drawn to B and C, will compleat a tripezia infcrib'd in a circle; which by 22 Euc. 3, has the two oppofite angles taken together equal to two right angles: hence the angle at the periphery will be 30° 15'. In like manner proceed with the 3 points AEB, and the angle at the periphery will be 91° 45'.

Then if from the center of the firft circle you draw lines to B and C, the angle contained between them will, by 20 Euc. 3, be double to that at the circumference, viz. 60° 30', and in the other circle it will be 183° 30'.

But it will be needlefs to explain the matter any farther, having already, in the laft year's diary, given as clear a demonftration as could be, without a large fcheme that would admit of all thofe lines and circles requifite thereto; what remains being purely trigonometrical, from whence I have deduced this followig anfwer.

				Tapper.	
			M. F. P.	M. F. P.	
Given {	From High Crofs to Tripontium	AB	8 1 5	8 1 5	
	From Eathorpe to Brinklow	CD	8 7 22	8 7 22	
	To complete the triangle —				
	Brinklow to High Crofs	DA	4 6 22	4 6 21	
	Tripontium to Eathorpe	BC	11 0 32	11 0 29	
	Brinklow to Tripontium	DB	6 4 16	6 4 20	
	Eathorpe to Bennones	CA	13 6 4	13 6 3	
	High Crofs —	EA	7 4 24	7 4 26	
Newbold to {	Tripontium —	EB	3 2 2	3 2 9	
	Eathorpe —	EC	8 1 16	8 1 11	
	Brinklow —	ED	4 1 16	4 1 20	

Mr. Rich. Tapper *anfwers in the manner following.*

Let $a =$ the diftance of Tripontium and Eathorpe; $c =$ the diftance of Tripontium and High Crofs = 2605 poles; $n =$ the diftance of Brinklow from Eathorpe = 2862 poles; then $a = \sqrt{ccnn + \frac{1}{4}n^4 |^2} - \frac{1}{2}nn = 3549.9109$ poles; which call d. Let $s =$ fine of 30° 15'; m its cofine, or fine of 149° 45'; $z =$ the fine of 88° 15', $\times$ its cofine, $1 =$ radius.

Imagine

Imagine the line which joins Newbold and Tripontium to be extended through the fosse, and a perpendicular let fall from Eathorpe upon it; also a perpendicular from High Crofs upon the said line. Then $d : s :: a : \frac{as}{d} =$ the fine of the angle made by the lines which join Tripontium and Newbold, and Tripontium and Eathorpe, $1 : a :: \frac{as}{d} : as =$ the length of the firft perpendicular, $1 : d :: m : ma =$ the diftance from Newbold to the place where the faid perpendicular cuts the extended line; and $\sqrt{dd - aass - ma} =$ the diftance of Newbold from Tripontium, by 47 Euc. 1.

Now $\frac{\sqrt{dd - aass}}{d} =$ the cofine of $\frac{as}{d}$. Then, $z : c :: \frac{\sqrt{dd - aass}}{d} : \frac{c}{zd}\sqrt{dd - aass} =$ the diftance from Newbold to High Crofs; $1 : \frac{as}{d} :: c : \frac{cas}{d} =$ the diftance from Tripontium to the place where the perpendicular from High Crofs would cut the line between Newbold and Tripontium, and $1 : c :: \frac{\sqrt{dd - ssaa}}{d} : \frac{c}{d}\sqrt{dd - ssaa} =$ the perp. alfo $z : \frac{c}{d}\sqrt{dd - ssaa} :: x : \frac{xc}{dz}\sqrt{dd - ssaa} =$ the diftance of the perpendicular from Newbold. Hence this equation, $1 - \frac{xc}{dz} \times \sqrt{dd - ssaa} = ma + \frac{sca}{d}$, which

reduced gives this theorem $a = \dfrac{d - \frac{cx}{z}}{\sqrt{\left|\frac{cs}{d} + m\right|^2 + \left|s - \frac{scx}{dz}\right|^2}}$

$= 2612\cdot7383$ poles.* $Q. E. I.$

Of

This queftion will be conftructed thus :

Conftruction.

In the firft place we have given, in a right-angled triangle, one leg $A B$, and the alternate fegment $C D$ of the hypothenufe made by the perpendicular $B D$; and the triangle will be conftructed as queftion 28 page 84. Again, the point E, where the three lines $A E$, $B E$, $C E$ make given angles with each other, will

Of the Eclipfes in 1725.

There will be fix eclipfes this year: Four times will the moon's dark body interpofe between the fun and earth, and hide his face; and twice will the earth interpofe, and hinder the fun from enlightening the moon: but of thefe only one of the moon will fall upon our part of the globe.

1. Sun eclipfed, the 2d of April, at 2 in the morning, invifible.

2. Moon eclipfed, the 16th of April, at 9 morning, invifible.

3. Sun eclipfed, 1ft of May, at 10 forenoon, invifible.

4. Sun eclipfed, 25th of September, at 7 morning, invifible.

5. Moon eclipfed, on Sunday the 10th day of October, at 7 o'clock in the evening, total and vifible.*

	Begin h. m.	Begin tot. d.	Midd.	End total	End	Dura	Dig.
Aftronom. Coventry	V 10	VI 7	VI 56	VII 4	8 42	3 31	21 56
Chattock, London	5 13	6 12	7 4	7 56	8 55	3 41	22 33
Child, Newport	5 28	6 26	7 14	8 :	8 59	3 32	21 36
Turner, Hull	5 15	6 9	6 5.	7 4.	8 36	3 20	
Leadbetter, London	5 29	6 27	7 1.	8 :	9 1	3 32	21 36
Sparrow, Nottingham	5 51	6 4	6 53	7 43	8 41	3 35	22 0

6. Sun eclipfed, 24th of October, at 11 at night, invifible.

New

---

* This eclipfe was obferved

1. At *Albano* by *S. Fr. Blanchini.*

h. m.
6 45 Tota' Immerfion.
8 10 Emerfion.
9 25 The End.

2. At *Briftol* by *Jer. Burroughs,* Efq.

App. Time
h. m. s.
7 31 20 Emerfion or beginning of light.
8 29 30 End.

New Questions.

I. *Question* 111, *by Mr.* Rich. Whitehead.

In fome company lately, mathematical fellows,
By the fide of a pond which flow'd hard by an alehoufe,
I began to be pert with my angles and fquares,
With my areas, my bafes, my cones, and my fpheres;
(For to talk of old Euclid, you muft know I am prone,
And when out of his elements, am out of my own;)
When fays one that fat next me, hold, prithee a word,
I'll hold you ten fhillings for the good of this board,
You don't tell me how far crofs the water 'tis wide, ⎫
From the place where we ftand to that tree on this fide, ⎬
And what fpace does each of thefe objects divide. ⎭
From the boat which now lies on the oppofite fhore,
With my fquare and a line (for they'd grant me no more)
I meafur'd in yards, as by figures you fee,   147¾
From beyond the faid houfe, ftrait with it and the tree.
Then fquare from this line I immediately went,
Or a right angle made, the page fhews the content,   475
Till the boat and the tree were exact in one line;
Then I meafur'd five hundred yards feventy and nine, 579
Quite up to the boat! then I, ftrait with the houfe,
From the tree meafur'd yards, as the page fairly fhews; 259
The meafure I took fquare from thence you muft note, 507⅓
Till I'd brought the faid houfe in a line with the boat:
Then up to the boat to make matters more clear,   ⎰
I meafur'd thofe yards which in margin appear.   674⅓
To finifh my working, what made me the quicker,
Was, I thought I cou'd do't, and make fure of the liquor;
But my boafted rules fail'd me, nor with all my deep fearches
Cou'd I find out the diftance, with its roods and the perches.
So ladies, I beg, for you're nice at difcerning,
You'd untie this hard knot, which has puzzl'd my learning.

II. *Question* 112, *by Mr.* Tho. Dod.

A wretch who fcorn'd to ufe th' appointed means
Heav'n's blifsful courts to reach, on's own thus leans;
Who, by mechanic art, a ladder rais'd
So high, it almoft all mankind amaz'd.
    Thus Jacob did, fays he, and why may'nt I
Scale heav'n as well as he? at leaft I'll try.
Wrapp'd in the clouds his head fecurely lies,
And feems inviron'd with the azure fkies;

A a

From

From which, 'tis faid, a fire-ball falling down,
Let off a cannon at the bafe, whofe found
Approach'd the ear at top in the fame time
The fire-ball fell from ladder fo fublime.
  · Tell me, ye fair, if he to heav'n was got,
Or how far foaring from this earthly fpot.

III. *Queftion* 113, *by Mr.* Tho. Grant.

A father, dying, left three daughters fair,
To whom he gave five thoufand pounds a year,
On fuch conditions as did them engage
To have their fhares proportion'd to their age;
But of their ages all that can be known,
To effect the purpofe is here under fhown.
    If to each daughter's age when fquared you
    Add the rectangle of the other two,
    Thefe * numbers will expofe themfelves to view.
Now ladies fair, I pray exert your fkill,
And tell them how to fatisfy the will.

        * 1000, 980, 920.

IV. *Queftion* 114, *by Mr.* Chrift. Mafon.

When mighty Jove this world immenfe did frame,
And beauteous form from dark confufion came,
No fooner he his fiat did difplay,
But the crude mafs of atoms all obey;
Each to their center with full fpeed did hafte,
And dawning light peep'd o'er the gloomy wafte:
Then boundlefs æther its expanfion made,
And the foundations of the heavens were laid.
For homogeneous matter was compact,
And earthly atoms into form did act:
The humid vapours into feas were made,
Which did the borders of the earth invade.
The groffer air around 'em both was fpread,
Like a foft cov'ring to a nuptial bed.
Plants, fruits, and flow'rs receiv'd their genial birth,
And fprung with vigour from the pregnant earth.
Then ftraight was hufh'd the elemental wars,
And formed thence fun, moon, and twinkling ftars;
Then fifh, and fowl, and beafts for food or prey;
And laftly man the whole for to furvey.
To contemplate and caft his eyes above,
See with furprize the heav'nly bodies move,

                                And

And with delight the wand'ring planets trace,
Which thro' the zodiac move from place to place:
Their motions and their magnitudes compare,
And thence conclude how uniform they are;
How ev'ry one keeps in their proper sphere,
And not, like mankind, strive to interfere.

But ere our thoughts an aerial journey take,
First let 'em here a suppofition make;
That if a ball upon the earth should weigh
Ten pounds in troy, and then cou'd it convey
To th' surface of each planetary sphere;
I pray unfold what weight it wou'd be there?

V. *Question* 115, *by Mr.* Bernard Annely.

Once on a lofty hill, whence ev'ry where
Around a glorious profpect did appear;
There many fair and wond'rous works difplay'd,
Of art and nature exquifitely made:
Amidft the various beauteous objects, I,
From far, a ftately fabric did efpy,
Rais'd on fair ground, that level ftood with me:
Its height, I found, one hundred foot want three.
That time the fun, going down, came in a line
Streight with the houfe and me; in height 'twas then
An hour's half quarter; by which the time did prove
Exact feven hours, and minutes fifty-five.
This on the firft of June. Then, ladies, fhew
The diftance of the building to our view?

VI. *Question* 116, *by Mr.* John Simmons.

An oblong clofe of meadow ground,
That is by water compafs'd round:
This by my paces I have found.
That the fum of each fide and end,
If to the diagonal be join'd,
Their total makes juft half a mile.
I've purchafed this clofe (or ifle);
And muft for it give, by bargain,
For each fquare yard, a penny farthing;
But know not what is the whole fum,
Which is the main thing to be known.
'There's one I afk'd knew well enough.
An old geodefian gruff,

That

That lately did the same survey:
Without large fees, no more he'd say
Than this, ' Less sides or ends are in extreme
' Ratio; and the diagonal's the mean
' Or greater segment, and each side a mean to them.
' With these hints you may find the answer,
' I'm very busy—pray be gone, sir.'
   Ladies, the sides and purchase pray declare
In your diary, the next year:
Nor care a fig for the surveyor.

The Prize Question.

  With what vast speed have all improvements run
Thro' all the ages since the arts begun.
Euclid's collections, full twenty centuries since,
Their mathematic knowledge may evince:
Archimedes the next age did produce,
Excelling all, was born in Syracuse:
From him geom'try did much light receive:
Rise of the globes and spheres to him they give:
The silver mix'd with gold in Hiero's crown,
By static art, he made the workman own.
Said, If he engine-footing had, cou'd move,
By force of screws, the mighty feat of Jove!
When Marcellus laid siege to Syracuse,
The Romans suffer'd, by his engine's use
In throwing stones; which show'red from the sky,
Like thunderbolts, the Romans to annoy.
But that great Roman soul strict orders gave
In storm and plunder, Archimedes to save.
But, cursed fate! by common soldier's hand
He's kill'd, whilst poring on his schemes in sand.
  What mathematics suffer'd by such blow,
Ah fruitful brain! still ages want to know.
By curious theorems, he the distance knew
To the enemy, where the stones he threw:
Who viewing from a corner of the wall,
Which there run straight, (an acute angle call)
Along the wall four hundred yards he pac'd,
Where he the warlike thund'ring engine plac'd:
Their camp to this line a right angle made;
Parallel to the wall's ditch, 'tis said,
Whose length and distance is not known;
But to our purpose, something hence is shown;
For at each station, when the camp he spy'd,
It cut the ditch's ends, as both he try'd.

From

From the firſt ſtation to the ditch, is found
Two hundred yards, meaſur'd alopg the ground.
From the enemy to the ditch's other end,
Two hundred ſixty yards our hiſt'ries ſend.
　　Let's know the diſtance where Marcellus ſtands,
And a theorem anſwering our-demands ?

1726.

Queſtions anſwered.

The 111th Queſtion anſwer'd by Mr. C. Maſon.

Let
and
put

1	$BD = b = 147\frac{3}{4}$	
2	$AB = c = 475$	
3	$AG = d = 579$	
4	$FG = f = 674\frac{1}{3}$	
5	$EF = g = 507\frac{1}{3}$	
6	$CE = h = 259$	
7	$DF = a$	

8 E.6.

$$8 \quad a : g :: a - f : \frac{ga - gf}{a} = Ge$$

$$9 \quad c - \frac{ga - gf}{a} : d :: c : \frac{cda}{ca - ga + gf} = AC,$$

for $c - g$ put $\dot{x}$

9 In. 2

$$10 \quad \frac{ccddaa}{xxaa + 2xagf + ggff} - cc = BC^2$$

10—1

$$11 \quad \sqrt{\frac{ccddaa}{xxaa + 2xagf + ggff} - cc} - b = DC$$

$$1\frac{1}{2} \quad \sqrt{aa - gg} - b = DC$$

$$13 \quad \sqrt{\frac{ccddaa}{xxaa + 2xagf + ggff} - cc} - b =$$

$$\sqrt{aa - gg} - h$$

A a 3
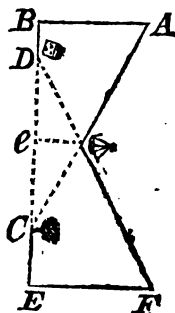
Which

Which equation reduced, and the fums collected, &c. gives $a = 1078.0833$: Then $a - f$ is the diftance between houfe and boat $DG = 403.7499$, and DC the diftance between the houfe and tree $= 692.2499$, and GC between the boat and tree $= 386.$* *Q.E.I.*

N.B. *The letter G is omitted at the boat in the preceding figure.*

II. *Queftion* 112 *anfwer'd by* Mr. Sam. Routie.

Sound moves 1142 feet per fecond; heavy bodies fall $16\frac{1}{12}$ feet in the firft fecond, according to Dr. Halley. Then put $a = 16\frac{1}{12}$, $b = 1''$, $x =$ ladder's height, $d =$ the time found flies $16\frac{1}{12}$ feet; $a : x :: bb : \dfrac{bbx}{a} =$ fquare defcent of the ball. And $a : x :: d : \dfrac{dx}{a} =$ the time found

moved

The final equation will be fimpler by fubftituting x for the unknown perpendicular Gc, the known quantities being as in the original folution: for then, by fimilar triangles,

$$g - x : g :: f : \frac{fg}{g - x} = DF,$$

and $c - x : c :: d : \dfrac{cd}{c - x} = AC;$

hence, by right-angled triangles and fubtraction,

$$DC = \sqrt{\frac{ccdd}{c - x|^2} - c^2} - b,$$

and $$DC = \sqrt{\frac{ffgg}{g - x|^2} - g^2} - b;$$

$$\therefore \sqrt{\frac{ccdd}{c - x|^2} - c^2} - b = \sqrt{\frac{ffgg}{g - x|^2} - g^2} - b.$$

And here if CE or b be fuppofed equal to BD or b, as thofe diftances are arbitrary, and might as well be meafured equal as unequal, then the final equation will become barely

$$\frac{ccdd}{c - x|^2} - c^2 = \frac{ffgg}{g - x|^2} - g^2, \text{ in which } x \text{ is eafily found.}$$

moved to the ladder's top. Confequently $\frac{dx}{a} = \sqrt{\frac{xbb}{a}}$,

whence $\frac{bbx}{a} = \frac{ddxx}{aa}$, $\therefore x = \frac{bba}{dd} = 81088\cdot085$ feet $=$

$27029\cdot36$ yards $= 15$ miles, 2 furlongs, 34 perches, 7 feet.*

† III. *Queſtion* 113 *anſwer'd by* Mr. John Turner.

Let $\begin{cases} aa + eu = b = 1000 \\ ce + au = c = 980 \\ uu + ae = d = 920 \end{cases}$ by the queſtion, then

$\left. \begin{array}{c} + 8u^8 - 18du^6 + 2bcu^4 - b^3uu + bbcc \\ + 18ddu^4 - c^3uu - 2bcd^2 \\ - bcuu + d^4 \\ + 5bcduu \\ - 7ddduu \end{array} \right\} = o.$

Which being collected and reduced gives the following numbers.

Ages.		Portions.		
		l.	s.	d. f.
The eldeſt 23·5276		1784	19	0¼·7568
Second 22·7788	caſh per annum	1728	2	8½·3738
Youngeſt 19·5991		1486	18	2¾·8694
C. Maſon —————		5000	0	0 0

IV. *Queſ.*

———————————————————

The ſolution will be a little clearer thus: Putting $a = 16\frac{1}{12}$,

$c = 1142$, and $x =$ the height. Then $\sqrt{a} : \sqrt{x} :: 1'' : \sqrt{\frac{x}{a}} =$

time of falling x feet; and $c : x :: 1'' : \frac{x}{c} =$ time of found's

paſſing over x feet; therefore $\frac{xx}{cc} = \frac{x}{a}$, and $x = \frac{cc}{a} = \frac{1142^2}{16\frac{1}{12}}$

$= 81088$ feet.

† III. Q U E S T I O N   113.

Various methods of ſolving this queſtion may be ſeen in Wallis, Kerſey, and Ronayne.

* IV. *Queſtion* 114 *anſwer'd by Mr.* Rich. Whitehead.

Supppoſe the ſun's parallax 10 ſeconds, and the magnitude of the earth according to Norwood's obſervations; then let a = the diſtance of the earth from the ſun, p = the periodical revolution of the earth, s = the periodical revolution of one of ♃ ſatellites. To find its diſtance from ♃ ſay

$$p^2 : s^2 :: a^3 : \frac{a^3 s^2}{pp} = \text{the cube of the diſtance ſought.}$$

And as the ſquares of theſe periods recip. ſo are the centrip. forces towards their reſpective central bodies.

Then for the weight of bodies on their ſurfaces, if the diſtances are equal, the weight will be as the quantity of matter the bodies contain. If the quantities of matter are equal, the weights will be reciprocally as the ſquares of the diſtances : *Ergo*, If neither are equal, the weight will be in a compound ratio. For, as the diſtance between the ſun and earth, and the quantity of matter in the earth, is to ten pounds, ſo is the diſtance of Jupiter, and quantity of matter, to the weight ten pounds would weigh on his ſurface; and ſo for the reſt. Hence ten pound of our troy weight will weigh on the ſurface of the ſun 244 pound, on Jupiter 20, on Saturn 12·75, on the empire of the bedlamites, viz. the moon 3·45.

Mr. Alexander Naughley's *anſwer.*

On the ſurface of the ſun 240, ♃ 19·9, ♂ 6, ☽ 5·15, ☿ 2·15, ♀ 2·08, ♄ 17.

Mr. *Tho.* Dod computes them from

	☉	♃	♄	☽
Mr. Whiſton's numbers — —	245	19·5	13·0	3·2
and Dr. Cheyne's theory —	79·3	6·4	4·2	

V. *Queſt.*

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* IV. QUESTION 114.

The proportions of the force of gravity at the ſurfaces of the planets, or the proportions of the weights of an equal quantity of matter at each, are now ſtated thus :

Sun	Moon	Mercury	Venus	Earth	Mars	Jupiter	Saturn
25	$\frac{1}{7}$	$\frac{4}{5·5}$	$\frac{4}{5}$	1	$\frac{1}{3}$	2	$1\frac{1}{3}$

Theſe being ſeverally multiplied by 10, we have

250	$3\frac{1}{7}$	$\frac{2}{1·6}$	8	10	$3\frac{1}{7}$	20	$13\frac{2}{3}$

for the weights required.

V. *Queſtion* 115 *anſwer'd by* Mr. J. Turner.

The time was 7 h. 55', and ⊙ ſetting in that latitude was 8 h. 2 m. 30 s. The longitude ♊ 21° 50' 17". Declination 23° 13' 53". Aſcenſional difference 30° 37' 3ᴄ". To find the latitude, having the declination and aſcenſional difference, tan. declination 23° 13' : radius :: s. aſcenſional difference 30° 37' : tan. lat. 49° 52' 53". Then there are given two ſides and an angle included, to find the third ſide the co-ſine of the ſun's altitude 57' 52". Then s. ⊙ altitude : height of the objeᴄt :: coſine of ſun's altitude : length of the ſhadow 5762·4 feet = 1920 yards.

VI. *Queſtion* 116 *anſwer'd by* Mr. Whitehead.

Let a = oblong's greater ſide, e = leſſer, u = diagonal, and b = 880 yards = ½ mile, in proceeding ſeveral ſteps you'll have $\sqrt{5} \times u = b - 2a$; put $g = \sqrt{5}$; then com-
pleating

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* V. QUESTION 115.

The time 8 h. 2¼ m. of ſun-ſet is found by adding 7¼ min.
the half quarter to 7 h. 55 m. the time when the ſun is direᴄtly behind the top of the edifice; at which time let O de-note the ſun's place, and ⊙ the point of ſun-ſet: alſo let Z be the zenith, and P the pole; and let the great circles be drawn as in the figure.
Then will ZPO be the hour angle of 7 h. 55 m. and ZP⊙ the hour angle of 8 h. 2¼ min. P⊙ or PO the given co-declination, PZ the co-altitude, ZO the
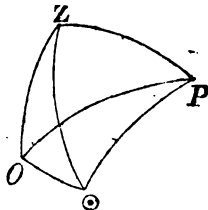
co-altitude at the time of obſervation, and Z⊙ the co-altitude at the time of ſetting, which will be a quadrant, it being the diſtance between the zenith and horizon.
Wherefore, in the triangle ZP⊙ are given Z⊙, P⊙, and the $\angle ZP$⊙ ; to find ZP the co-latitude. Then in the triangle ZPO, will be given ZP, PO, and their included $\angle ZPO$; to find ZO the co-altitude at the time of obſervation, and, laſtly, the diſtance will be equal to the length of the ſhadow, which is the baſe of a right-angled plane triangle whoſe perpendicular is the height of the building, and the angle at the baſe the ſun's altitude; whence appears the reaſon of the laſt ſtating in the original ſolution.

pleating the fquare $aa + ka + \dfrac{kk}{4} = \dfrac{bbg - bb}{14 - 4g} +$

$\dfrac{bbgg - 2bbg + bb}{49 - 28g + 4gg} = \dfrac{45bbg - 10bbgg - 35bb}{880 - 588g + 168gg - 16g^3} =$

$\dfrac{12098496 \cdot 879012673 +}{32 \cdot 3065910301404 8} = 374490 \cdot 04968136201.$

$a + \dfrac{k}{2}$ (i. e. $a + \dfrac{bg - b}{7 - 2g} = 430 \cdot 299969) = 611 \cdot 9559213549.$
Hence the greater fide of the oblong is $a = 181 \cdot 65595$; *e* the
leffer $= 142 \cdot 80907$; diagonal $= 231 \cdot 06994$. Content 25942
$\cdot 1189$ yards at $1d. \frac{1}{4}$ comes to $135 l. 2s. 3d. \frac{1}{4} 594.$

The author of this queftion, in the 4th line, by the words
the fum of each fide and end, defign'd to have meant one
fide and one end : Then the anfwer would have been 65097
fquare yards, and purchafe $339 l. 11 d. \frac{3}{4}$; but the expref-
fion will much eafier mean both fides and both ends, and the
anfwer above truly folves the queftion.*   *The*

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* VI. Q U E S T I O N 116.

As the queftion is worded, the fum of the four fides and the
diagonal muft be equal to half a mile, and the diagonal a mean
proportional between the end or breadth and fum of the diagonal
and the faid end or breadth.

Wherefore if $z =$ the diagonal, and $x =$ the breadth; then
$xz + xx = zz$, and hence $x = z \times \dfrac{\sqrt{5} - 1}{2}$. Alfo, by right-

angled triangles, the length $= \sqrt{zz - xx} = z\sqrt{1 - \overline{\dfrac{\sqrt{5} - 1}{2}}^2}$

$= z\sqrt{\dfrac{\sqrt{5} - 1}{2}}$. So that the breadth, length, and diagonal,

are to each other as $\dfrac{\sqrt{5} - 1}{2}$, $\sqrt{\dfrac{\sqrt{5} - 1}{2}}$, and 1; and there-
fore are in continual proportion.

Now the fum of this diagonal with twice the length and breadth
is $\sqrt{5} + \sqrt{2\sqrt{5} - 2}$; and then, by proportion, as this fum
is to half a mile (the fum given in the queftion), fo is each of the
above proportional quantities to the breadth, length, and diagonal
of the figure required. Wherefore half a mile or 880 yards drawn

into each of the fractions $\dfrac{\dfrac{\sqrt{5} - 1}{2}}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, $\dfrac{\sqrt{\dfrac{\sqrt{5} - 1}{2}}}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$,

and $\dfrac{1}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, will produce the required breadth,
length, and diagonal.

The Prize Question answer'd by Mr. Sam. Marriot.

In this right-angled triangle where-
in a line is drawn parallel to the base,
there is given the base $= 400$; that
segment of the hypothenuse next the
base $200 = c$; and the alternate seg-
ment of the cathetus $260 = d$. To
find the cathetus, &c.
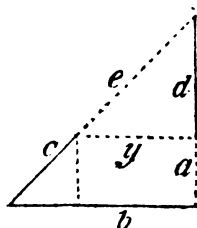
$$d + a : b :: d : \frac{d\,b}{d+a} = y,$$

$$e + c : b :: e : \frac{b\,e}{e+c} = y = \frac{b\,d}{d+a} \text{ per fim. triangles. Hence}$$

$bde + bea = bdc + bed$, or $bdc = bea$, and $\frac{dc}{a} = e$. Again,

$$bb + dd + 2da + aa = \frac{ccaa + 2dcca + ccdd}{aa} \text{ per 47 E. 1.}$$

Hence $a^4 + 2da^3 + bb \left. \begin{array}{c} \\ + dd \\ - cc \end{array} \right\} aa - 2ccda = ccdd.$

Then $a = 141°73$; $a + d = 401°73$ the distance sought;
$c + e$ from first stat. to the camp $566°908$; $y = $ length of
the ditch $258°883$ yards.

Mr. R. Tapper *answers it thus*:

Let $a = $ the distance of the wall from the ditch, $b = 260$
yards, $n = 200$, $m = 400$.

$$1 + \frac{b}{a} + \overline{\sqrt{nn - aa}} = m. \text{ which reduced will be}$$

$a^4 + 2ba^3 \begin{array}{c} + bb \\ + mmaa - 2bnna = bbnn. \\ - nn \end{array}$

Here a will be found $141°7005$; $a + b = 401°7005$ the
distance of the camp of Marcellus from Syracufe.

The solution of this question may more fully be seen in
Ward's Introduction, p. 334.

Of the Eclipses in 1726.

Twice this year will the moon's dark body interpose between the sun and earth, and hide his face; and twice will the earth interpose, and hinder the sun from enlightning the moon: but only two of them will be visible in our part of the globe.

1. Sun eclipsed the 22d of March, about half an hour past 2 o'clock in the afternoon, invisible, by reason of the moon's south latitude, but will be pretty large, and seen about the Straights of Magellan.

2. Moon eclipsed the 5th of April, at 2 in the afternoon, invisible, she being then below our horizon; but in the eastern parts of Tartaria, Mogol, China, &c. it will be above 8 digits eclipsed on the northern limb.

3. Sun eclipsed the 14th of September, a quarter past 5 in the afternoon, visible.*

		Begin.	Midd.	End	Dur.	Dig.
		h. m.	h. m.	h. m.	h. m.	
Astronom. Car. at	Coventry	IV 25	V 17	VI ·7	1 42	5 46
Mr. Chattock,	Coventry	4 26	5 17	6 17	1 50	6 44
Mr. Chattock,	London	4 28	5 25	6 18	1 49	6 46
Mr. Leadbetter,	London	4 44	5 37	6 27	1 43	6 3
Mr. Sparrow,	Nottingham	4 23	5 12	6 6	1 44	6 1
Mr. Child,	Newport	4 44	5· 37	6 27	1 43	5 4
Mr. Turner,	Hull	4 20	5 14	6 2	1 42	5 29

4. **Moon**

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* This eclipse was observed ·

1. At *Lisbon* by F. *J. Bapt. Carbone*.

					True time.		
					h.	m.	s.
Beginning	—	—	—	—	3	59	50
Middle	—	—	—	—	4	58	30
End	—	—	—	—	5	56	50

The digits eclipsed were 7¾.

2. At *Ingolstat* by the Fathers of the Society of *Jesus*.

The beginning at 5 h. 17 m. 52 s.
The sun's semi-diameter measured exactly 16′ 00″.

4. Moon eclipfed on Friday the 30th of September, at 5 o'clock in the morning, vifible.*

	Begin.	Midd.	End	Digits
Aftronom. Car. at Coventry	III 55	V 4	VI 13	4 45
Mr. Chattock, London	3 26	4 50	6 14	6 36
Mr. Leadbetter, London	3 53	5 3	6 · 14	4 58
Mr. Turner, Hull	3 34	4 49	6 4	5 28
Mr. Sparrow, Nottingham	2 30	4 55	6 0	5 27

A Letter

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* This eclipfe was obferved

1. At *Lifbon* by F. *J. Bapt. Carbone.*

	True time correct.
	h. m. s.
Beginning of the penumbra —	14 37 00
Beginning of the eclipfe — —	14 57 20
End of the eclipfe — — —	17 33 30
End of the fenfible penumbra —	17 54 00

The quantity eclipfed 6¼ digits.

2. At *Pekin* by F. *Ignat. Kegler.*

	Correct time.
	h. m. s.
Beginnning — — — —	12 49 0
Total Immerfion — — —	14 46 30
Emerfion — — — —	15 27 30
The end — — — —	16 26 0

The apparent diameter of the moon 32′ 30″.

3. At *Padua* by S. *J. Poleni.*

	App time.
	h. m. s.
Senfible penumbra — —	16 16 44
Beginning of the eclipfe ——	16 21 19

Clouds prevented the obfervation of the end.

Diary Mathem.　　B b

A Letter to the Author.

——— 'Tis natural to moſt part of mankind to deſpiſe what they don't underſtand, and to paſs their judgments from appearances : And ſince your diary is but ſmall, and call'd an almanac, they who are ignorant of the mathematics, are apt to think meanly of that part of it, and conclude your correſpondents very fond of having their names in print, if not charge them with enormous pride and downright folly, in having their names put to the queſtions they propoſe to anſwer. I therefore being a party concern'd, could wiſh that ſome of your correſpondents would vindicate us from ſuch imputations, and ſet the diary and our performances in a true light. And ſuch perſons ought to be told, Firſt, of the extenſive uſes of mathematical learning, and of the infinite advantages they are to mankind ; that the ſtudy is not only delightful, but quickens the invention, ſtrengthens the judgment, and enlarges the intellectual faculties. Secondly, that in the diary there has been exhibited a great number of difficult, curious, and uſeful queſtions, in all branches of the mathematics, not to be found in any author, with the beſt methods of ſolving them, which in any other method probably would never appear to the world. Thirdly, That the diary has incited and led many perſons to the ſtudy of mathematics, who otherwiſe perhaps would not have turned their thoughts that way, and has alſo exerciſed thoſe who have before ſtudied them ſo as not to forget what they learnt, and by exciting an emulation whereby they extend their mathematical knowledge. Fourthly, That your correſpondents who anſwer all or moſt of the queſtions, muſt well underſtand almoſt all parts of the mathematics, which doubtleſs is praiſe enough ! That thoſe who anſwer only ſome few of the queſtions muſt underſtand arithmetic very well, if they are not acquainted with geometry. So that the leaſt knowing of the anſwerers are capable of any buſineſs wherein the knowledge of arithmetic and ſome part of geometry are requiſite. The ſolving of ſome queſtions does take up much time, and exerciſes as well the practic as theoretic part of the mathematics. And ſurely to employ one's leiſure hours pleaſantly, innocently, and profitably, with inconſiderable charge, is highly commendable ; eſpecially ſince time is generally fooliſhly and expenſively thrown away, &c.

<div align="center">·Yours,   *Richard Whitehead.*</div>

New Questions.

I. *Question* 117, *by Mr.* Richard Whitehead.

Having lately the great fatisfaction to meet
With fome quaint virtuofos, at an elegant treat;
In a bowl of good nectar we drown'd ev'ry care,
And our chat and our liquor did equally fhare:
How fweet pafs'd our time, as we fat round the table,
Meafur'd out by the true horological ladle.
  The bowl of flint-glafs, of particular form,
Where this minute hand did with fuch ev'nefs turn,
As when full, of our mirth it had been 'the gay fource,
Gave, when empty, the rife to a learned difcourfe;
(For emptinefs oft, by the bye, has been found
To occafion deep talk, and difcourfes profound)
To be fhort, in the firft place they all did agree, $\Big\}$ 5·98
An hyperbolic conoid its infide to be,
Whofe abfciffa was inches and parts as you fee.
The line next, the inches and decimals fhews,
Which its tranfverfe diameter went to compofe.   6·93
  The bowl's leaft diameter they all did opine
Five inches to meafure, and parts twenty-nine :   5·29
And they took, pray obferve it, its fides which went ftraight
To be part of the afymptotes; and to give us more light,
Of either of thefe fee the length * fhewn below.
This, they faid, was all that a perfon need know;
Its inner diameter right to unfold,
How much it might weigh, and what punch it might hold.
I allow'd what they faid, and I told them, with eafe,
I cou'd fend them an anfwer to queries like thefe,
So fanguine I was; yet on fetting about it,
After all my great workings, I found myfelf routed.
  So ladies I hope, fince I'm put to a fhift,
You'll give your moft humble admirer a lift.

     * $8\frac{727609}{918000}$

II. *Question* 118, *by Mr.* Chrift. Mafon.

Propitious ladies, who are fkill'd in arts,
Divide ten thoufand into two fuch parts,
When each of them the other has divided,
Both quotients make juft five (if right decided\.

     III. *Quef-*

III. *Question* 119, *by* Mr. John Turner.

As I was walking out one summer's day,
To see the verdant fields and meadows gay,
By chance I did a geodesian spy,
Who was surveying then a close, hard by,
Of oval form; but such an odd way he went,
By which to find its area or content,
As I before that time, nor since, e'er saw.   *feet*
From one o'th' foci to the curve he drew *feet*
Three lines, whose lengths the page doth shew : 200
The angle between the first and second, 313·62
Twenty-five degrees exact was reckon'd ; 872·62
Between the second and third he knew,
'Twas threescore and five precisely true.
From hence the area you may quickly find :
And one thing more let's know, pray be so kind ;
Quite cross the said ellipse a ditch is made,
Which cuts the transverse axis, (as he said)
Two hundred feet from center, as you may
Suppose, in manner it inclining lay :
The lesser segment of the ditch I know,
Is of all lines the shortest you can draw
From that point i'th' axis to periph'ry ;
What length's each part, ladies, let us see.

IV. *Question* 120, *by* Mr. John Simmons.

An oval marble fountain's to be made,
'Midst of a fine partarre, give's your aid,   }
To tell the true dimensions, from the shade
Of the forced water, thro' a jet d'eau ;
Which ten foot at right angles it must throw
Above the fountain's brim ——— observe, the sixth o' June
The shade o' th' top, by the meridian sun,
Gives half the conjugate; ——— likewise, at two
Hours and five minutes after, come and view
Where the shade must cross the fount's periphery,
Ten inches short of the shade's length you'll see
A point, which there does bound the curvity.
The garden's latitude is known to be 52° 56' }
But if that day the sun shou'd not shine clear,   }
Exert your skill, and these four things declare :
Transverse, conjugate, and the depth pray tell,
When sixty wine hogsheads can the fountain fill.
This lin'd with lead all o'er, thus * thick, the weight
In pounds avoirdupois, inform me right.

    * $\frac{3}{5}$ of $\frac{4}{9}$ of an inch.

         V. *Ques-*

V. *Queſtion* 121, *by Mr.* Tho. Grant.

Not far from Cairo, in the Egyptian land,
Amongſt their ancient monuments does ſtand
A ſmall round temple, whoſe circumference
Is juſt one hundred yards and ſeven-tenths.
    Its convex front is artfully adorn'd
With hyeroglyphics exquiſitely form'd.
    A ſpiral tube encircles it around,
Making an angle with the level ground,
Of ſixty-one degrees and minutes five,
Till at the temple's top it doth arrive.
From whence, thro' this ſaid tube an iron ball
By its own gravity let freely fall,
Will to the bottom run in ſeconds eight:
From hence, I pray, declare the temple's height.

VI. *Queſlion* 122, *by Mr.* Sam. Marriot.

    A grandſire to his four grandchildren ſaid,
I have a piece of land was once ſurvey'd;
An oblong form i'th' midſt o'th' marſh doth lie,
This formerly was fenc'd about; but I
(Being weary of the charges) threw it ope,
And eat it main with all my neigb'ring folk,
Left nothing ſtanding but a thriving oak
At the eaſt corner; leſt I ſhould be fain
In time to come, to fence it out again.
    The length, the breadth, the content too of it
Were fooliſhly upon looſe paper writ:
Yet I the ſame laid by (I thought) with care,
But now I want it, 'tis I know not where.
But this may uſeful be: I did reſolve
Diag'nal wiſe to hedge this cloſe in half:
A line let fall from th' corner of the cloſe
To the diagonal right angles ſhows,
Which cut a ſegment juſt of chains ſixteen
From the diagonal; and if't had been
Prolong'd two chains, would touch the other ſide;
Theſe two croſs lines would this oblong divide
Into four parts, ſuch as I give to you
reſpectively; and this is all I know.
    Now, fair ones, leſt they the land ſhould loſe,
Pray in your next theſe four ſhares expoſe.

Thee

The Prize Question.

Fam'd Eboracum, once Brigantium's height,
Renowned was by many a worthy wight.
Four emperors did there receive their birth,
And three inhum'd, fleep in that hallow'd earth.
Severus and Conftantius there repofe,
And Chlorus too, in peace with all their foes.
The fourth moft fam'd, was the great Conftantine,
Whofe name thro' all the chriftian world did fhine;
Was the firft emperor that wou'd embrace
The chriftian faith, and baptiz'd at that place.
What ftill adds lufter to renowned York,
A fabric ftands of ftately gothic work;
Whofe lofty tow'rs o'erlook the fpacious plain,
And view'd with wonder o'er a vaft champaign.
The weary trav'ler fees the diftant place,
Believes him there, amends his flack'ned pace;
Pleas'd the refrefhing profpect to furvey,
Each ftride he lengthens to beguile the way.
For high in air the lofty turrets rife,
Peep o'er the diftant plains before the dazzled eyes.
As once I travell'd t'ward that ancient place,
I pry'd to fee't, tho' diftant many a pace;
By optic tubes, to help th' defective eye,
With th' horizon, St. Peter's I did fpy:
When twenty miles I nearer was, did fee
The apex then exalted one degree.
My eye was juft five feet fix inches high.
By what is fhewn, the height I pray defcry?

1727.

Queſtions anſwer'd.

I. *Queſtion* 117 *anſwer'd by* Mr. Chriſt. Maſon.

$cC = b = 9\text{'}445$
$Ds = c = 2\text{'}645$
$AD = d = 8\text{'}777$
$cs = a = \text{?}$
$b - a = Cs$

$a : c :: b : \dfrac{bc}{a} = CB$

$b - a : a :: d : \dfrac{da}{b-a} = Dc$

$a : \dfrac{da}{b-a} :: b : \dfrac{bd}{b-a} = Ac$

$\dfrac{bbcc}{aa} = CBq$

$\dfrac{bbdd}{bb - 2ba + aa} = Acq$

$\dfrac{bbdd}{bb - 2ba + aa} - bb = CBq = \dfrac{bbcc}{aa}.$

Which equation reduced, &c. gives $a = 2\text{'}93$, from which all the other dimenſions may be eaſily found. Then *per Archim. de Conoid & Spheroid, Def.* 3, the truncated cone $A d e B b t a$ will be = a cylinder generated by the parallelogram $C t e g$. Ergo, from the fruſtum $A d e B A$, take that cylinder, the remainder will be = the ſolidity of the hyperbolic conoid $a t b a$; to which cylinder add the fruſtum $d D E e d$, the ſum will be equal the ſolidity of the bowl = 197'873 inches. The ſolidity of the conoid = 499'774 inches = 2'1635 wine gallons.

Then by $\left\{\begin{array}{l}\text{Phil. Tranſ.} \\ \text{Ward,}\end{array}\right\}$ an inch of $\left\{\begin{array}{l}1\text{'}54282 \\ 1\text{'}493037\end{array}\right\}$ ounces glaſs weighs $\left\{\begin{array}{l}\text{avoird.}\end{array}\right.$

And the weight $\left\{\begin{array}{l}(1)\ 305\ \text{oz.} = 19\text{lb. }1\text{ oz.} \\ (2)\ 294\frac{1}{2}\text{oz.} = 18\text{lb. }7\text{ oz.}\end{array}\right\}$ avoirdupois. of the bowl
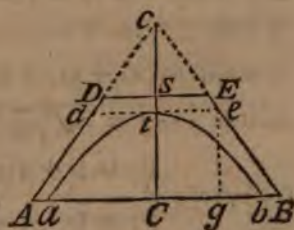
II. Queſ

* II. *Queſtion* 118 *anſwer'd by Mr.* R. Whitehead.

The two numbers $\left\{\begin{matrix} 1726{\cdot}73164 \\ 8273{\cdot}26835 \end{matrix}\right\}$ added make 4·99999 &c.

† III. *Queſtion* 119 *anſwer'd by Mr.* W. Gill.

Dr. Keil, in his Aſtro. Lect. gives a method of determining, an ellipſe from 3 lines given in length and poſition, cutting each other in the focus.   The

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* II. QUESTION 118.

Let x and y denote the two numbers, s their ſum, and q the ſum of their alternate quotients.——Then $x + y = s$, and $\frac{x}{y} + \frac{y}{x}$ $= q$: Hence $xx + yy = qxy$, and $xx + 2xy + yy = ss$; or, by ſubſtitution, $qxy + 2xy = ss$; therefore $4xy = \frac{4ss}{q+2}$; and, by ſubtraction, $xx - 2xy + yy = ss - \frac{4ss}{q+2} = \frac{q-2}{q+2} \times ss$; therefore $x - y = s\sqrt{\frac{q-2}{q+2}}$.

Conſequently $\left\{\begin{matrix} x = \frac{1}{2}s + \frac{1}{2}s\sqrt{\frac{q-2}{q+2}}, \\ y = \frac{1}{2}s - \frac{1}{2}s\sqrt{\frac{q-2}{q+2}}. \end{matrix}\right.$

† III. QUESTION 119.

It is demonſtrated, by the writers on conics, that if C be the center and F the focus of an ellipſe, and in the tranſverſe axe BA produced there be taken CD a third proportional to CF and CA, and from any point G in the curve GE be drawn parallel to BD and meeting DE parpendicular to it in E, and FG be drawn; then FG will always be to GE, in the conſtant ratio of CF to CA.—— Wherefore, if G, H, I be the three given points, or ends of the given lines FG, FH, FI, drawn from the focus F; and there be drawn HG, IH, and produced to K and L ſo that HK be to GK as FH to FG, and IL to HL as FI
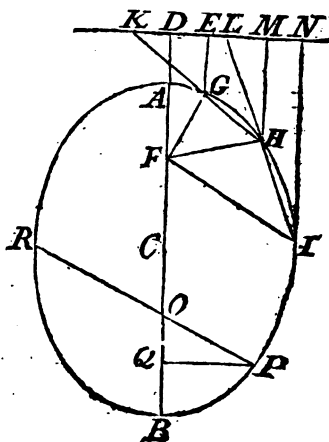
The tranfverfe diameter 1000 feet, conjugate 600, the content of the field 10 a. 3 r. 10 perches, the angle of inclination of the tranfverfe 64° 21′. From the doctrine of fluxions, if the leffer fegment be fuppos'd to be the hypothenufe of a right-angled triangle, alfo a minimum, and a perpendicular let fall upon the tranfverfe diameter. The bafe of the faid triangle will be a fourth proportional to the tranfverfe, the latus rectum, and the diftance of the perpendicular from the center of the ellipfis, that is $1000 : 360 :: 200 + x : x = 112\cdot5$. Hence the leffer part of the ditch $= 259\cdot8$, greater $= 330\cdot66$, and the whole length $= 590\cdot46$.

IV. *Quef-*

to *FH*; and then if *KL* be drawn, and perpendicular to it *IN*, *HM*, *GE*, *FD*; and laftly *FD* be divided in *A* in the given ratio of *FG* to *GE*; then *A* will be the end of the tranfverfe, and the whole of the ellipfe is thence determined.——For, *KH* being to *KG* as *FH* to *FG* by the conftruction, and *KH* to *KG* as *MH* to *EG* by fimilar triangles, therefore *FH* will be to *FG* as *MH* to *EG*, or *FH* to *HM* as *FG* to *GE*; and in the fame manner *FI* : *IN* :: *FH* : *HM*; wherefore in general *FI* : *IN* :: *FH* : *HM* : *FG* : *GE* :: (by the above cited property) *CF* : *CA*; whence the center *C* and the whole ellipfe becomes known.

Again, for the fhorteft line *OP* that can be drawn from the given point *O* in the axe to the curve; fince it muft evidently be perpendicular to the curve or to the tangent in the point *P*, it may be determined from that confideration alone and the property of the curve, independent of fluxions; and from thence will eafily arife the property of it mentioned in the original folution, and as is actually determined at *prop.* 10 *lib.* 5 *Apol. Con.* viz. *AB* : latus rect. : *CQ* : *OQ*; hence the point *Q* is found, and of confequence *OQ*; and then *OR* as in queftion 103 page 246.

* IV. *Queſtion* 120 *anſwer'd by* Mr. Maſon.

Given the lat. —	52° 56′	As ſine of the altitude 52° 11″
Its complement —	37 4	Is to the height 120 inches
Sun's declination add	23 25	So coſine altitude — 37° 49ᶜ
Sun's merid. altitude	60 29	To length of ſhadow 93·155 in.

As s. ſun's altitude	60 29	From which ſubtract 10 inch.
To the height obj. —	120 in.	Remainder 83·155.
So is coſ. ſun's alt.	29° 31″	
To length ſhadow —	67·989	As coſine ſun's altitude 37° 49ᵃ
		To ſine time paſt noon 31 15
As radius		So coſine ⊙'s declin. 66 34
To coſ. time from noon	58° 45′	To ſine ſun's azimuth 50 55
So is coſ. lat. — —	52 56	
To tang. of a 4th arch	32 51	As radius — — 90 0
		Is to — — — 83·155
Which ſub. fr. ⊙'s diſt. of pole		So coſine azimuth — 50° 55″
leaves a 5th arc =	33° 44′	To the ordinate *ea* = 52·4

Coſine 4th arch —	57 09	As radius
To coſine 5th arch —	56 16	To — — — 83·155
So ſine of the lat. —	52 56	So ſine —· — 50° 55′
To ſine of the altitude	52 11	To *de* — — 64·53

Letᵗ

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* IV. QUESTION 120.

The ſpherical calculations, in the original ſolution above, will be evident by applying the given declination, latitude, and hour to the ſpheric triangle in page 227; for if *Z P* repreſent the co-latitude, *P* ⊙ the co-declination, and their included angle *P* the hour from noon, all which are given; then *Z* ⊙ will be the co-altitude, and the ∠ *Z* the azimuth, both which are hence eaſily found.

Again, for the ellipſe, inſtead of the jet d'eau ſuppoſe a pole of 10 feet high erected in the center *d* of the ellipſe; then will the ſhadow of it at noon be the ſemi-conjugate axe *dc*, and 10 inches leſs than the ſhadow of it when the azimuth is equal to the ∠ *a d C* will be the ſemi-diameter *db* = *da*. Which are eaſily determined as in the original ſolution.

Every thing elſe in the original ſolution is very well determined except the tranſverſe axe, which may be better found thus, by the common property of the ellipſe, as $\sqrt{dC^2 - ae^2}$: *de* :: *d C* : *d T* the ſemi-tranſverſe.

Let $ea = b = 52\cdot4$
$dC = c = 67\cdot989$
$de = d = 64\cdot53$
And $et = a$. *Quære a?*
$$dd + 2da + aa : cc :: da$$
$$: \frac{ccda}{dd + 2da + aa} = bb.$$

Reduced, $bbaa + 2bbda - ccda = bbdd$. In numbers produces $a = 36\cdot86$. Then $1 : \cdot7854 :: Tt \times cC : 2164\cdot4668$ inches $=$ the area, by which divide the given content, gives the depth $40\cdot33$ inches. Add twice the thickneſs of the lead to each diameter, and once to the depth : from which elliptical cylinder ſubtract the given content, gives the inches of lead 11614, which according to Ward's ſpecific gravity of lead, is equal to 76116 ounces avoirdupois $= 2$ tun, 2 hund. 1 quar. $25\frac{1}{4}$ lb. weight.*
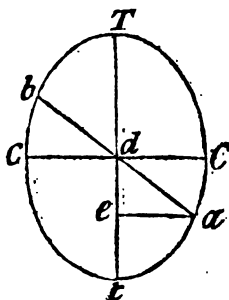
* N. *Queſtion* 121 *anſwer'd by Mr.* Whitehead.

The propoſer has either unlimited or unhing'd the queſtion, by giving the circumference of the tower incoherent with the time ; either alone would have limited it.

According to Gallilæus, and experiments made by ſeveral ingenious artiſts of late, as

$1 : 16\frac{1}{12} :: 8'' \times 8'' = 64 : 1029\frac{1}{3} =$ the ſpace a body will deſcribe a perpendicular deſcent in $8''$ of time. Then

As the ſine of given angle $ACB = 61° 5'$
Is to the ſide $—— AB = 1029\frac{1}{3}$
So is the radius
To the hypothenuſe $AC = 1175\cdot81$

Then let fall the perpendicular aB, and while a body accelerates the ſpace AB, another will deſcribe the ſpace Aa, along the inclin'd plain AC, as has been demonſtrated by the illuſtrious Sir Iſaac Newton. Having found the ſegment $Aa = \dfrac{AB^2}{AC} = 901$, &c.

Say, as radius : $Aa = 901$, the length of the tube :: s. of the given angle $Aab = 61° 5'$: $Ab = 788\cdot72$ feet, the height required.
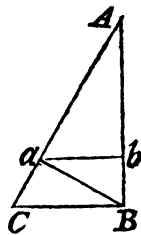
Mr. Grant's *solution to the* 121*st question, taken from the Diary for* 1729, *and who thinks Mr.* Whitehead's *solution was not right.*

As 1 : 193 : 64 :: 12352 inches = the perpendicular descent of the body by gravity in 8″ of time : Then as the radius : sine of 61° 5′ :: 12352 : 10812 inches = the space described in 8″ by a body descending along a plain that makes an angle of 61° 5′ with the horizon, which would be the tube's length were it a right line, but being a spiral to the temple which the question supposes a cylinder whose periphery is 100·7 yards; it is evident, that as the ball descends it will also by the tube's curvature be carried in the said periphery, therefore it will be acted on by a *vis centralis*, in a direction parallel to the horizon, which will not forward the ball's descent, but will constantly diminish it, and consequently the velocity that would arise therefrom, which will occasion the ratio of the spaces described by the ball descending in the tube, to the times of their description to be always variable. Wherefore I compare in a ratio, as the semi-ordinate of a conic parabola to their respective abscissas, whence the following analysis : where x = tube's length the ball runs in 8″.

Radius : cos. 61° 5′ :: x : ·483537x = to an arch described in 8″, in the periphery, which squar'd, divided by the diameter, gives ·0002026167xx = the space in 8″, agitated only by the central force; which multiply by x^2, and make it the abscissa of a parabola convex to its axis, x its ordinate, and the parameter will come out = 4935·427 in. = a, the parabol. curve, by compounding the motions along the ordinate and abscissa, will be = 10812 inches = the space in 8″, by a body descending along the inclin'd plain. Then, by the doctrine of fluxions, x = 6175 inches = 514$\frac{7}{12}$ feet the tube's length, and radius : s. 61° 5′ :: 6175 : 5405 inches = 450 feet, the temple's height.*

<div align="right">VI. <i>Ques-</i></div>

After all Mr. Grant's labour and time spent in the solution of ,this question, Mr. Whitehead's solution is right. For the side of the tube, by impelling the ball in the horizontal direction, does not alter its perpendicular velocity or descent; and therefore the spiral may be considered as a streight inclined plane in the solution.

VI. *Queſtion* 122 *anſwer'd by Mr.* Sam. Rouſe.

Draw DA. Then $\triangle DAB = \triangle FAB$ by Eucl. I. 37,
$\therefore \triangle DAC = \triangle FBC$.

Put $AC = b = 2$, $CF = a$,
$CD = 16 = d$, $CB = e$.

E.VI.8.	1	$b : e :: e : a$
$\therefore$	2	$ba = ee$
But	3	$ae = bd$
$3 \div e$	4	$a = \dfrac{bd}{e}$
$2 \div b$	5	$a = \dfrac{ee}{b}$
4 and 5	6	$\dfrac{bd}{e} = \dfrac{ee}{b}$
$6 \times$	7	$dbb = eee$
$7 \, w \, 3$	8	$\sqrt[3]{bbd} = e = 4$ chains.
E. 8. 6.	9	$AC : CB :: CB : CF = 8$ ch.
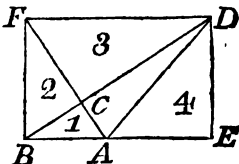
A.R.P.
(1) $BCA = 0\ 1\ 24$
(2) $BFC = 1\ 2\ 16$
(3) $CFD = 6\ 1\ 24$ }ſhar.
(4) $ACDE = 7\ 2\ 16$

Total $16\ 0\ 0$

This queſtion is in page 367 Hill's Arithmetic.

The Prize Queſtion anſwer'd.

Let $\{$	1	$r =$ radius of the earth $= tc$,
	2	$b = bd$ or $ef =$ height of eye;
36 E. 3.	3	$2rh + hh = bt^2$
$3 \, w \, \bar{z}$"	4	$\sqrt{2rh + bd} = bt$
Then	5	$bf - bt = tf$,
And	6	$\angle cea = 91°$ per queſt.

Then find the angle tce, and line te;
find the angles tec and etc; ſubtract
the angle etc from 90°, it leaves the
angle eta. Again, to the angle tec
add $\angle cea$, which ſum ſubtract from
360, leaves the angle tea. Then the angles tea and ate
ſubtracted from 180, leaves the angle tae. Then
    As ſine $tae : te ::$ ſine $tea : ta$. And $\sqrt{tc^2 + ta^2 - tc}$
$= ao = 260$; feet, the height ſought; which is ſomething
more than the real height of the tower of York cathedral.
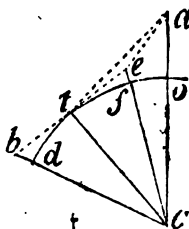
Of the Eclipses in 1727.

Twice this year will the moon's dark body interpose be-
tween the sun and our part of the earth, and hide part of
his face from our light.   But only one will be visible.

1. Sun eclipsed, on Saturday the 11th day of March, at 8
at night, but not visible to us by reason the sun is then set.*

2. Sun eclipsed, on Monday the 4th of September, at 7 in
the morning, about 2 digits, invisible.   The calculation by
Street's Caroline Tables, for the meridian of the city of
Coventry.†

The beginning at Coventry — . —	VI	31
The middle or greatest observation .	VII	3
The end — — — —	VII	35
The whole duration — — — .	I	5
Digits eclipsed south — — 1	56	58

New

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* This eclipse was observed

At *Vera-Cruz* by Mr. *J. Harris.*

	App. time
	h. m.
The beginning — — — —	0 49½
Middle as near as could be judged — —	2 30
End about the N. N. E. part of his disk, —	3 59½

† This eclipse was observed thus :

At	By	Beginning	End Ant. Merid.
		h. m. s.	h. m. s.
Lisbon	F. J. Carbone	— — —	7 9 2 true time
Padua	J. Polenus	— — —	8 38 42 true time
Rome	J. D. Maraldi	— — —	8 44 10 true time
Bologna	E. Manfredi	— — —	8 36 6
Wirtemberg	J. F. Weidlerus	7 18 19	8 29 51

New Queſtions.

I. *Queſtion* 123, *by Mr.* Rich. Whitehead.

As a Philomath Cato, with attention profound,
Was preparing a map of ſome neighbouring ground;
And to objects remote was directing his eye,
With his body half bent, 'twas my chance to come by:
We fell into talk (for you muſt know for ſome years
I've been a ſmall trader in angles and ſquares);
He told me what methods he took, and what ways,
To determine the diſtance of this from that place.
Says I, you go wrong, friend, or at leaſt round about,
To arrive at this thing, there's a much nearer route.
On this, Euclid's ſon, with a ſneer, made a motion,
That I'd practiſe what he thought was only a notion.
What I ſaid I cou'd no ways refuſe to make good,
And the caſe that he choſe for my trial thus ſtood:
Three towns there were lying (to prevent any blunder,
Call *B*, *C*, and *D*) many paces aſunder;
The diſtance of each one of theſe from a town
That was placed within them, call'd *L*, was well known, }
It being in miles and in yards as below is ſhown. }
From the towers of the two firſt-named places I took }
The angles from one to another; pray look
At the bottom*, for there their true meaſures appear:
But from none of thoſe tow'rs, if I look'd a whole year,
Cou'd I've ſeen the town *L*, it was plac'd down ſo low:
For want of which height I was forc'd to let go
My deſign, which I boaſted I'd ſoon bring to paſs,
And deſiſt from my work with no very good grace.
So, ladies, I hope, for this once, you'll deſcend,
To aſſiſt a poor well-wiſhing batchelor friend.
For the future, no more ſuch vain toils I'll purſue,
And leave off ſurveying——unleſs 'tis of you !

* The angle $B = 63^\circ 10' \cdot 96766$; $C = 77^\circ 0' \cdot 07237$; $D = 37^\circ 49'$.

The lines $\begin{Bmatrix} BL & 7 \\ CL & 6 \\ DL & 4 \end{Bmatrix}$ miles $\begin{Bmatrix} 528 \\ 880 \\ 704 \end{Bmatrix}$ yards.

II. *Queſtion* 124, *by* Philoſophicus.

Strephon unfortunate ! by cruel fate,
He's quite bereav'd of his moſt happy ſtate.
Celia, whom he dearly did adore,
Bright objeċt of his amorous deſire,
She's loſt, unheard of by ſome ill adventure.
He's oppreſs'd with utmoſt grief for his great loſs,
In ſighs and tears he wails his wretched caſe :
No pains he ſpares, the fair to have again,
But O, ſhe's gone ! his ſearch proves all in vain :
Yet, fill'd with fierce deſires, he will purſue
A ſearch inceſſant, ſtill her fate to know.
Ev'n thro' all parts o'th' ſpacious world he'll rove,
Nothing ſhall him deter, ſo inſpir'd by love.
   After a long and tedious courſe of travel,
Having laſted all its great fatigue and toil,
He to a diſtant country then is thrown,
A place fam'd for an oracle divine.
Now, cries the joyful youth, my hopes revive !
This ſage diviner may ſome tidings give.
Then ſtraight he haſten'd to the ſacred place,
Where ſtood the oracle, and there his caſe
Before him laid ; then earneſt did invoke
His pow'r : when thus the ſacred ſtatue ſpoke :
This place is in the latitude of forty-eight,
If hence on this meridian thou mov'ſt ſtreight
With equal motion, tow'rds the great equator,
And paſs preciſe o'er fourteen miles each hour,
Accounting ſtill the motion that was given
Thee, by the earth's diurnal revolution :
When by this compound motion thou haſt gone
The ſpace of fifteen hundred leagues and one,
There end thy journey ; for thou would'ſt b' arriv'd
Unto the place where doth the fair reſide.
   Now, ladies, your bright wit muſt this explain ;
And tell what latitude the nympth was in.

III. *Queſtion* 125, *by Mr.* John Turner.

Within the northern artic circle ſtand
Three hills, which o'er the circumjacent land-
Raiſe their aſpiring top, in ice involv'd,
And ſnow by Phœbus' rays not yet diſſolv'd,
A land-mark well unto the ſeamen known,
When driv'n by ſtorms and tempeſts up and down,

                                                     U'th'

I'th' fpacious depth ; far diftant they appear,
With heads invelop'd in the atmofphere;
More fam'd than Teneriff, or Andes hill.
The height of *A*, for fo the firft I call,
In poles is thirty-two; the fecond *L*,
Twice forty-eight, not more; the third, or *C*,
Its altitude exactly fifty-three.
And from the bafe of *A* to *L* is found,
Two hundred poles meafur'd upon the ground.
Now't happens on a certain day i'th' year,
(But which I leave to you for to declare)
That th' utmoft limits of the top of *A*
Its fhade fhall tranfit thro' the foot of *C*;
L's fhade thro' *A* and *C* will take its way,
And that of *C* thro' *A* alternately.
From hence pray tell what's the fun's declination,
And alfo what the pole's true elevation,
Where thefe phænomena will true appear,
And you'll oblige your humble ferviteur.

IV. *Queftion* 126, *by Mr*. Tho. Dod.

'Tis to you, lovely ladies, I fue and fubmit,
(Who out-vie Sidrophel in magic and wit)
For folution of this knotty problem propos'd,
By which undertaking my fenfes are doz'd:
To find by what canon the fquares you do fill
Which are magical call'd, and by that try your fkill,
To place all thefe numbers * fo that the amount
Juft half a fcore ways feventy-four you may count:
If you'll anfwer but this, now yourfelf do affure,
I will meddle with what they call magic no more.

* 8, 9, 10, 11, 14, 15, 16, 17, 20, 21, 22, 23, 26, 27, 28, 29.

V. *Queftion* 127, *by Mr*. Tho. Williams.

Our modern nat'ralifts difpute—Whence came
The water that deftroy'd the earth's firft frame?
Some bring it from the moon; and fome have thought
That from above the firmament 'twas brought:
Others—that 'twas created for that end,
Or from a deep abyfs did then afcend.
The laft the facred writ doth intimate,
As Woodward has explain'd it to's of late:
The which abyfs (with Halley) he wou'd have
Concentric with the earth, an orb concave.

If fo — an alternative change fuppofe;
Let air fubfidé, whilft water earth o'erflows;
And while the earth's a fea, let air in place
Of water fill up the orbicular fpace.
For prefent ufe (with Burnet) we'll agree,
That the antidiluvian earth might be
Of mathematical rotundity;
And that th' abyfs did hold this weight * in air,
Which we'll admit no heavy'r there than here.
From hence, fair ladies, thefe two things unfold:
How deep the flood? how much th' abyfs might hold?

          * 1000000000000000 tuns avoird.

VI. *Queftion* 128, *by Mr.* Chrift. Mafon.

The earth with Luna frifking round, do run
Their annual courfe about their lord the fun;
And thro' th' ecliptic, as they fteer their way,
Defcribe the feafons, meafure night and day;
Yet hang on nothing in the limpid air;
And as they move, their maker's praife declare.
Befides their motions, they do gravitate,
Which different actions equiponderate;
And tho' each fphere a center has, yet they
One common center have, which may be call'd their way.
    Where is that place, kind artifts, fhew it to me,
    When thofe two orbs at their mean diftance be?

VII. *Queftion* 129, *by Mr.* Sam. Roufe.

Once I a noble ftructure did behold,
Whofe tow'ring walls, magnificent and rare,
Within were grac'd with curious effigies,
Drawn by fweet touch of fam'd Angelo's art:
The top with glitt'ring ftars was garnifh'd o'er,
In imitation of the fpangled arch of
Heav'n's fpacious canopy. In midft
Of this rich place a golden candleftick
Orbicular, adorn'd with branching flow'rs,
Sufpended, hung fupported by a line
Fix'd to the roof. This candleftick, one faid,
Ofcillates or vibrates in an hour's fpace
A thoufand times: He likewife faid, this line
From top o'th' candleftick, thence to the ground,
Was in extream and mean proportion known.
This ftately fabric's height, fair nymphs, declare,
From marble floor up to the lofty roof.

                                      The

The Prize Question.

In fam'd Sicilia's ifle a garden lies,
From ftorms defended, and inclement fkies:
Fenc'd with a green inclofure all around,
Tall thriving trees confefs the fertile ground.
A fylvan fcene in folemn ftate difplay'd,
Flutters each feather'd warbler with a fhade:
The gentle fpirit of the weftern gale
Eternal breathes on fruits untaught to fail;
The ruling orbs no wint'ry horrors bring,
Fixed in th' indulgence of perpetual fpring:
Here fpices in parteres promifcuous blow,
Not from Arabia's field more odours flow:
The order'd vines in equal ranks appear,
And verdant olives flourifh round the year;
Here grapes difdolour'd on the funny fide,
And there in autumn's richeft purple dy'd;
Beds of all various herbs, for ever green,
In beauteous order terminate the fcene.
Sev'n chryftal ftreams, from fev'n fair fountains flowing,
The lovely landfcape grace with foft murmurs,
In wild meanders flowly run, as feeming
Unwilling to forfake the pleafing foil.
I'th' midft of a grafs-plot, form'd with artful care,
Its radius fifty feet, being circular,
Two rectilinear walks from the center flow,
Making an angle as exprefs'd below: 55 deg.
The length of A, from thence twice fifty-four,
Of B juft eighty feet, nor lefs, nor more;
From whofe extremities two lines muft be
Drawn back to the circle's periphery,
Where (meeting) they muft equal angles form,
On each fide, with a tangent to be drawn
To the faid point of concourfe: Now what are
The lengths of thefe two lines, I pray declare?

1728.

Questions answer'd.

I. *Question* 123 *answer'd by the proposer's method.*

Put $a = BD$, $b = LB$, $d = DL$, $c = CL$, $m =$ fine $\angle CDB = 6131\cdot369$, $n =$ fine $\angle PCD = 7899\cdot767$, $r =$ radius $= 10000$, $s =$ fine $BCD = 9743\cdot748329$, $t =$ fine $\angle CBD = 9076\cdot46563$.

By trigonometry,

$$\frac{ta}{s} = CD, \quad \frac{mta}{rs} = CP, \text{ and } \frac{nta}{rs} = PD.$$

By oblique triangles,

$$\frac{aa + dd - bb}{2a} = KD, \quad \frac{ttaa + sscc - ssdd}{2sta}$$

$$= CE, \text{ and } \frac{ttaa + ssdd - sscc}{2sta} = ED.$$

By similar triangles,

$$PD : PC :: KD : KG = \frac{maa + mdd - mbb}{2na},$$

$$PD : DC :: KD : DG = \frac{raa + rdd - rbb}{2na},$$

$$CD : CP :: GK : GH = \frac{mmaa + mmdd - mmbb}{2rna},$$

$$CD : DP :: KD : DH = \frac{naa + ndd - nbb}{2ra};$$

hence $GD - ED = GE =$

$$\frac{rstaa + rstdd - rstbb - nttaa - nssdd + nsscc}{2nsta},$$

Then by similar triangles,

$CP : PD :: GE : EL = rstaa +$ &c. divided by $2msta$,

or $EL = \dfrac{2153869732771305 8aa - 11\cdot839151262}{a} = \dfrac{qaa - p}{a}$;

also
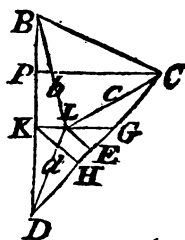
also $CE = \dfrac{46575841908309173\, aa + 12\cdot28641236}{a} = \dfrac{kaa+l}{a}$

therefore $LE^2 + CE^2 = LC^2$;

that is, $\dfrac{qqa^4 - 2qpaa + pp + kka^4 + klaa + ll}{aa} = cc$,

or $2pqaa + ccaa - 2klaa - qqa^4 - kka^4 = ll + pp$;

that is, by division and substitution, $xaa - a^4 = z$,

or $xe - ee = z$, by putting $e = aa$;

hence $e = aa = \dfrac{x}{2} + \sqrt{\dfrac{xx}{4} - z} = 127\cdot6958908986685$,

and $a = 11\cdot300260066 = BD$, and the rest

$$\left.\begin{array}{l} CD = 10\cdot526383 \\ CB = 7\cdot1108241 \end{array}\right\} \text{ miles} = \left\{\begin{array}{ccc} 11 \text{ m.} & 2 \text{ f.} & 16 \text{ p.} \\ 10 & 4 & 8 \\ 7 & 0 & 35 \end{array}\right.$$

Mr. *John Turner* has very curiously wrought this answer by trigonometry, and an algebraical process to this biquadratic adfected equation,

$$\overline{1 + g^2}\,x^4 + 2dxx \begin{array}{l} -4cc \\ = \begin{array}{l} -dd \\ -bb \end{array} \\ +2gh \end{array}$$

$x = \sqrt{ss - t + s} = 11\cdot2983$ miles, $10\cdot525$, and $7\cdot11$.

II. *Ques.*

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* I. QUESTION 123.

Describe the triangle Bcd similar to the proposed one, or whose angles shall be equal to the given ones : then, by prob. 31 Simpson's Geometry, determine the point l such, that the three lines Bl, cl, dl may be in proportion to each other as the three given distances BL, CL, DL : upon Bl take $BL =$ the given distance of B from L ; and draw LD, LC parallel to ld, lc ; and join D, C : so shall B, C, D, L be the four points required.

· Which is too evident to need a formal demonstration.
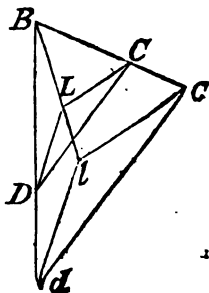
II. *Question* 124 *answer'd by Mr.* Turner

Let $SP = 4503$ miles $= d$, $b = 14$, and $c = 1039$ the number of miles which every point of the equator is carried through in the space of an hour, by the earth's diurnal revolution; then the ratio of PL to SL, will be ba to ca: But $b^2 a^2 + c^2 a^2 = dd$ Euc. 47. 1. Hence $a = \sqrt{\dfrac{dd}{cc + bb}}$, confequently $PL = ba = 60.676$ miles, the difference of latitude, and the latitude arriv'd in will be $46°\ 59'\ \frac{1}{4}$ north.

This may likewife be folv'd trigonometrically, and has fome affinity to current failing, the motion of the earth reprefenting the current's motion, the man being carried by the compound motion from P to S: 'but each point of the parallel of $48°$ does not run through 1039 miles per hour, and the line PS will indeed be a fpiral line upon the globe.

Mr. *Geo. Brown* has well anfwered and demonftrated this queftion, and found the latitude to be $46°\ 16'$: but the operation and fcheme my room will not admit.*

                                         III. *Quef-*

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* II. QUESTION 124.

The original folution to this queftion is not right, becaufe the motion in the parallel is made conftantly equal to that at the equator; whereas the intent of the queftion feems to be, to find the fpiral defcribed on the globe by a point, which is urged with a given conftant velocity in the direction of the meridian, and a given conftant angular velocity around the pole in the direction perpendicular to the meridian; the rates being 14 miles on the meridian to the 24th part of the parallel of latitude.——Or it may be conceived by fuppofing a point to move along the brafs meridian of a globe, at the rate of 14 miles while the globe turns round 15 degrees, the motion anfwering to an hour; for then the parts of the globe paffing directly under the point, will trace out the fpiral.

Wherefore, if x be put for the cofine of the variable latitude, and confequently $\sqrt{1 - xx}$ its fine to the radius 1; alfo $a = 14$ miles, and $b = 1\text{-}15$th part of the equator: fince $bx =$ the motion per hour in the parallel of latitude, and $\dfrac{\dot{x}}{\sqrt{1 - xx}} =$

* III. *Queſtion* 125 *anſwer'd by* Mr. BROWN.

There's a demonſtration of this in Sir Iſaac Newton's Uni-verſal Arithmetic, too large to inſert, by which I make the latitude 81° 30′, and ſun's declination 17° 22′.

Mr. *Maſon,* Mr. *Whitehead,* and ſome others ſay this queſtion is unlimited, or at leaſt admits of more true anſwers than one: but having received none but the above, I ſhall not here give my judgment till further trial be made at a more leiſure time, except Mr. *Bent*'s latitude 80º 45′, decli-nation 19° 27′.

IV. *Queſ-*

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the fluxion of the arch of the meridian or abſciſſa of the ſpiral,

we ſhall have as $a : bx :: \dfrac{\dot{x}}{\sqrt{1-xx}} : \dfrac{b x \dot{x}}{a \sqrt{1-xx}} =$ the fluxion of the parallel or ordinate of the ſpiral; then the ſum of the ſquares of theſe fluxions of the ordinate and abſciſſa will be equal to the ſquare of the fluxion of the curve of the ſpiral, or fluxion of the ſpiral $\dot{z} = \dot{x} \sqrt{\dfrac{aa+bbxx}{aa-aaxx}}$, or $= \dot{x}\sqrt{\dfrac{1+qxx}{1-xx}}$

by putting q for $\dfrac{bb}{aa}$. Now, by Cor. 2 pa. 218 Menſuration, it will be found that this expreſſion is the fluxion of an elliptic arc whoſe ſemi-axes are 1 and $\sqrt{\dfrac{aa+bb}{aa}}$. Wherefore if the circle

whoſe radius is 1 be circumſcribed by the ellipſe whoſe tranſverſe ſemi-axe AC is $= \sqrt{\dfrac{aa+bb}{aa}}$, and BD be the degrees or arc of the latitude, and EDF be drawn parallel to AC; then CF will be $= x$, and the arc $AE = z$ the above fluent, or length of the ſpiral from the pole: Alſo Ee will be the length of the ſpiral between any two latitudes BD, Bd. So that if BD be the given latitude of 48°, and DE be drawn parallel to AC; then take $Ee = 4509$ miles the propoſed length of the ſpiral, and draw ed parallel to ED; ſo ſhall Bd be the la-titude required.

* III. QUESTION 125.

This queſtion has evidently been made from prob. 55 of Sir *Iſaac Newton's* Arithmetic, where a full ſolution may be ſeen.

IV. *Queſtion* 126 *anſwer'd.*

Mr. *Elias Colbourn* ſays, if the numbers as given be placed in four rows, you need only let the diagonals ſtand, and croſs places with the other numbers as in theſe ſquares.

8	9	10	11
14	15	16	17
20	21	22	23
26	27	28	29

8	28	27	11
23	15	16	20
17	21	22	14
26	10	9	29

The numbers plac'd as given in the queſtion.

Tranſpos'd, which makes 74 ten ways, viz. laterally, tranſverſly, and diagonally.

Aſpatia ſays, the method of filling all ſorts of magical ſquares with the magic cubes, may be ſeen at large in the memoirs of the royal academy of ſciences for 1710, page 124, by Monſ. Saurier, in his Conſtruction Generale des Quarrés Magiques.

V. *Queſtion* 127 *anſwer'd by Mr.* Whitehead.

According to Mr. *Boyle*, the weight of water is to that of air as 1000 to 1.   Mr. *Ward* makes a cubic inch of water to weigh 578697 ounces avoirdupois.   Mr. *Norwood* makes a degree of the great circle $= 69\frac{1}{2}$ miles; hence the diameter of the earth is $= 504606222$ inches fere. And 3584000000000000000coco ounces of air will fill the abyſs; and thence 3584019 ..... ounces of water will fill the ſame. Then as 578697 ounces : 1 inch :: 35840, &c. ounces : 6193223742303830847575765 $=$ number of inches in the abyſs, which added to thoſe which are in the earth, the ſum will be equal to the ſolid inches in the ſphere of the flooded earth: from the diameter of which take that of the earth, and divide the remainder by 2, the quotient is 77397·7752 inches $= 6449\cdot8146$ feet $= 2149\cdot9382$ yards $= 1$ mile 389 yards.

This anſwer agrees pretty near with the propoſer of the queſtion.   There were many others who ſolv'd it: but in anſwers to queſtions of this nature, there will be ſome conſiderable difference, by reaſon the proportions are taken from authors which do not exactly agree; as (1) In the proportion of air to water, (2) In the weight of water, (3) The geometrical miles in a degree, (4) In the diameter to the circumference.

VI. *Queſ-*

* VI. *Queſtion* 128 *anſwer'd by Mr.* T. Williams.

The common center of gravity of the earth and moon goes through the magnis orbis ſo, that the areas deſcribed by the radii to the ſun are proportional to the times; the accelerating gravities are as the quantities of matter in thoſe bodies; the maſs of the earth is given equal to 390089562838232025134476 cubic feet; the diameter of the ☽ to the diameter of the ☉, as her apparent ſemi-diameter to her horizontal parallax. Hence her magnitude 80168249291644691 6225 feet: The attractive force will be the ſame in reſpect to their diſtance from the common center of gravity, as in reſpect of the whole diſtance be-tween them.

Let *S* denote the ſun, *M C* the mag-nus orbis deſcrib'd by the common center of gravity of the earth *T*, and the moon *L*, *C* the ☽ in octant, her mean diſtance $60\frac{2}{5}$, ſemi-diameter $= 1309095060$ feet $= TL$. Now are the ☽ and ☉ tend to *C* as to one another, $CT : CL :: $ maſs in *L* : maſs in *T*.

Therefore $CT = 26361759$ feet $= 4083$ miles, and $CL = 1282733200$ feet $= 242752$ miles.

Mr. *Maſon*, the propoſer, anſwers thus: $d =$ mean di-ameter $= 268923$ miles, $q =$ the quantity of matter in the earth, and $1 = $ ☽, $a =$ diſtance of the common centers from the ſun; $q : 1 :: $ maſs ☉ : maſs ☽, $qa = d - a$ per ſtatics, and $qa + a = d$; hence $a = \dfrac{d}{q + 1} = 5899\cdot34$ miles.

Mr.

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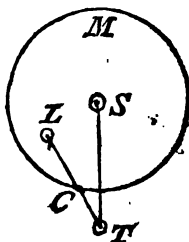
* VI. QUESTION 128.

If *e* be the quantity of matter in the earth, and *m* that in the moon, or any other two bodies, and *d* their diſtance aſunder. Then, per ſtatics, as $e + m : d$

$$:: \left\{ \begin{array}{l} m : \dfrac{dm}{e + m} = \text{the diſtance of the earth} \\ e : \dfrac{de}{e + m} = \text{the diſtance of the moon} \end{array} \right\} \text{from the com-}$$

mon center of gravity.

Diary Mathem.   D d

Mr. *Turner* has curioufly explain'd this, and fays the author ought to have told whether in ♂ or ♀, &c. but that nothing certain can be laid down, fince we cannot truly determine the diftance and magnitude of the fun; and that regard fhould be had to their denfities, and fpecific gravities, &c.

* VII. *Queftion* 129, *anfwer'd by Mr.* Da. Nairne.

The pendulum vibrates 1000 per hour $= 16\frac{2}{3}$ per minute, and one of $39\cdot2$ inches vibrates 60 per minute; alfo they being in a duplicate ratio of their vibrations, therefore the length of the candleftick will be found 508 inches; and the candleftick above the floor 314. Hence the whole height $= 822$ inches $= 68\cdot5$ feet.

The Prize *Queftion* anfwer'd.

Join AB, AC and draw ms and Bw $\perp AC$, $mq \parallel AC$, $mf \parallel AB$; draw md fo that $\angle mdA = \angle AmC = AmB$, and mr that $\angle Arm = AmB$. Then the triangles Amb, Amr are fimilar, as alfo AmC and Amd: alfo the triangles rmq, dmf are fimilar. Then let $a = 108 = AB$, $b = 80 = AC$, $c = 61\cdot95 = Aw$, $d = 88\cdot47 = Bw$, and $r = 50 = Am$; alfo $x = As$, $y = ms$. Then $mf = \dfrac{ay}{d}$, and $Sf = \dfrac{cy}{d}$,
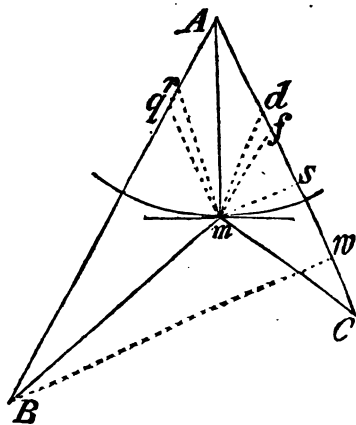
which

As $1000^2 : 3600^2$ or as $10^2 : 36^2 :: 39\cdot2 : 39\cdot2 \times \overline{3\cdot6}^2 = 508$ inches the length of the cord or line.

Again, if $x =$ the whole height, and $a = 508 =$ the greater part. Then $x : a :: a : x - a$; hence $xx - ax = aa$, and $x = \dfrac{1 + \sqrt{5}}{2} \times a = 821\cdot96$ inches $= 68\frac{1}{2}$ feet nearly.

which taken from x, we have $Af = x - \frac{cy}{d} = mq$, and $Aq = mf = \frac{ay}{d}$. Again, in the like triangles, Amb, Amr, $Ar = \frac{rr}{a}$; and in AmC, Adm, $Ad = \frac{rr}{b}$, which taken from $Af = x - \frac{cy}{d}$, we have $df = x - \frac{cy}{d} - \frac{rr}{b}$. Also $rq = \frac{ay}{d} - \frac{rr}{a}$. Then $mq : qr :: mf : df$, that is $x - \frac{cy}{d} : \frac{ay}{d} - \frac{rr}{a} :: \frac{ay}{d} : x - \frac{cy}{d} - \frac{rr}{b}$; and, crossing extreams and means, $xx - \frac{2cyx}{d} - \frac{rrx}{b} + \frac{ccyy}{dd} + \frac{rrcy}{db} = \frac{aayy}{dd} - \frac{rry}{d}$; or for $aa - cc$ put dd, and transpos'd $\frac{ccyy}{dd}$, &c. comes $x^2 - \frac{2cyx}{d} + \frac{rrx}{d} - \frac{rrx}{b} = yy - \frac{rrcy}{db} - \frac{rry}{d}$. Proceeding finds $x = 45\cdot8068 = As$. Then the angle sAm may be found; and two sides and a contain'd angle given in each, to find $Bm = 70\cdot32$, and $Cm = 39\cdot63$ feet the answer.* $I.T.$

Of

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* *The* PRIZE QUESTION.

This question may be otherwise solved thus:

Putting $a = AB$, $b = AC$, and $r = Am$, as above; and also s and $c =$ fine and cof. $\angle BAC$,
x and $\sqrt{1 - x^2} =$ fine and cof. $\angle BAm$, and
z and $\sqrt{1 - z^2} =$ fine and cof. $\angle CAm$, to the radius 1.

Then, by trigonometry, $\dfrac{ax}{r - a\sqrt{1 - x^2}} =$ tang. $\angle AmB$, and $\dfrac{bz}{r - b\sqrt{1 - z^2}} =$ tang. $\angle AmC$; but these angles are equal to each other by the question; therefore we have this equation, $\dfrac{ax}{r - a\sqrt{1 - x^2}} = \dfrac{bz}{r - b\sqrt{1 - z^2}}$.

Bu

Of the Eclipses in 1728.

There will be four eclipses this year; twice will the moon's dark body interpose between the sun and our part of the earth, and hide part of his face from our sight: and twice will the earth interpose between the sun and moon, and hinder the sun's enlightning the moon.

1. Moon eclipsed on Wednesday the 14th day of February, about 7 in the morning, visible.

	Begin. h. m.	Midd.	End	Digits
Astronom. Car. at Coventry	V 44	VII 10	VIII 36	9 32
Leadbetter, London —	5 49	7 13	8 48	9 13
Joh. Newton, Melt. Moberry	5 55	7 .7	8 19	9 26
T. Sparrow, Nottingham	5 47	7 16	8 45	10 16
☽'s lat. north, descending	39' 47″	——	30' 28″	——

The

But, again by trigonometry, $z = s\sqrt{1-x^2} - cx$,

$$\text{and } \sqrt{1-z^2} = sx + c\sqrt{1-x^2};$$

these values of z and $\sqrt{1-z^2}$ being substituted in the above

equation, we have $\dfrac{ax}{r - a\sqrt{1-x^2}} = \dfrac{bs\sqrt{1-x^2} - bcx}{r - bsx - bc\sqrt{1-x^2}}$;

which equation, reduced, gives

$$4a^2b^2x^4 - 4a^2brsx^3 + a^2r^2x^2 + 2a^2brsx + a^2b^2s^2 = 0;$$
$$+ b^2r^2$$
$$- 4a^2b^2 \quad - 2ab^2crs - b^2r^2s^2$$
$$+ 2abcr^2$$

from which biquadratic equation x may be found.

The moon will fet about the middle· of the eclipfe, fo that the end of it will not be vifible to us.*

2. Sun eclipfed the 28th of February, at 8 at night, but invifiblc, by reafon the fun is then fet.

3. Moon eclipfed the 8th day of Auguft, at 5 at night, the moon being then below our horizon. The eclipfe will be over before fhe rifeth, and fo invifible.†

4. Sun eclipfed the 24th of Auguft, at 1 in the morning, invifiblc.

New Queſtions.

I. *Queſtion* 130, by *Mr.* Rich. Whitehead.

Near the place where I fojourn there happen'd of late,
Thro' time and negleft, a fharp caufe of debate.
　Three friends own'd a meadow, for fo many years,
Till they could not determine the bounds of their fhares.
A worm-eaten parchment, much gone to decay,
Was produc'd, full of lines, which they call'd a furvey:
This was thumb'd, and look'd over and over again,
And with fpeftacles too, but alas ! all in vain:
Nay, the fchoolmafter's learning, tho' deep, nought avail'd;
And where fhou'd they go when the fchoolmafter fail'd?
Howe'er, being told that, my fancy to pleafe,
I've us'd myfelf often with queries like thefe;
　　　　　　　　　　　　　　　　　　　They

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* This eclipfe was obferved

At *St. Michael the Archangel* by *J. de Caſtro Sarmento.*

					h.	m.	s.
Beginning	—	—	—	—	14	3	35
End	—	—	—	—	17	0	37

† This eclipfe was obferved at *Pekin*, thus:

			h.	m.
Beginning of the penumbra	—	10	54	
Beginning of the eclipfe	—	—	11	2
End	—	—	—	14	0

They all faid they'd treat me, and thank me to boot,
If I'd fet the thing right, and end the difpute.
The mead had four fides, a tripezium or fo,
As the mufty old manufcript gave me to know:
Thefe fides, eaft, weft, north, and fouth, as they went,
The letters A, D, E, and C reprefent.
AD had fix chains, forty links, (to go on) }
EC twice five chains, links fix, three, and one; }
And AC contain'd chains twice feven, links none. }
Two lines from the ends of the fide A and C }
Iffuing, met, on the oppofite fide E and D, }
At a point call'd, for fake of diftinguifhing, B, }
And there form'd an angle (you know what I mean)
Equal the fum of fixty degrees, more by eighteen ;
And after this manner were feen to divide
Into its three three-corner'd portions the mead.
Moreover, thefe lines their proportion thus bore;
BC to BA, was as three is to four;
BD to BE the fame ratio did fhew,
As three, in the fcale of proportion, to two.
    Phoo ! faid I, Mr. Pedant, don't know what his trade is;
If nonplus'd by this, he's no great Archimedes.
I fhall foon fet this matter to rights, I don't doubt;
But I found, after all, I was plaguily out:
I thought of this nature 'twas eafy to do things,
But I find that fpeculation and practice are two things.
    Of ye, Diarian fair, the favour I afk,
That you'd pleafe to perform what I took for my tafk:
For me 'tis too much; but there's nought can furprize
Or pofe you, whofe wits are as bright as your eyes !

II. *Queftion* 151, *by Mr.* Tho. Dod.

A youth who in numbers fome progrefs had made,
And took himfelf now for a notable blade,
Came with his progreffion*, and faid he cou'd fhow,
How far a ball, conftantly moving, wou'd go;
Which, fays he, the firft hour fhould go forty miles clever,
Thirty-five in the fecond, and fo on for ever.
    I allow'd he might do it, and bid him fuppofe
The ratio as 6 to . ... what I nor he knows;
And that it went fo many † miles fecond hour:
Likewife this fum to his, be as nine is to four.
He try'd, and fell fhort, as a long thing to do:
So now he refers himfelf, ladies, to you.

* Geometrical.   † $46\frac{9}{16}$.

III. Qu

III. *Queſtion* 131, *by Mr.* John Hartley.

In ancient times, when royal David's ſon
Did reign in glory at Jeruſalem,
He built the ſpacious temple of the Lord,
With implements, and rich utenſils ſtor'd.
A molten ſea among the reſt was made,
For the prieſt's uſe intended, as 'tis ſaid:
Upon twelve brazen oxen it was ſet:
Two thouſand baths it wou'd contain; and yet
A line of thirty cubits wou'd ſurround
The ſame: It was cylindrical and round.
The depth five cubits was, and hand's breadth thick:
But the diameter I'm to ſeek;
For tho' ten cubits be the number told,
With the periphery this will not hold;
For ſo the circumference you may ſee,
Wou'd thirty-one and more than four-tenths be.

Now, I ſuppoſe, the jewiſh cubit was
Longer than ours; but what's their bath, alas!
Is hard to fix, ſince authors are divided:
But ladies, by your arts 'twill be decided.

My firſt requeſt, fair ladies, don't deny,
The bath's content, and cubit's length deſcry? ⎫
And theſe dimenſions how I muſt apply, ⎬
To make the ſea two thouſand baths contain, ⎪
No arbitrary meaſures to retain, ⎪
But what you from an author can maintain. ⎭

One favour more, once more I crave your aid;
Suppoſe this molten ſea of copper made,
And full of water pure, I pray, declare
What weight avoirdupois the oxen bear.

IV. *Queſtion* 132, *by Mr.* Tho. Williams.

In Oxfordſhire's a little meadow ground,
A ſection of a parabola found,
Having three ſides; one curv'd, we'll call *C M*,
Being ſo made by Charwell's chryſtal ſtream:
The other two be'ng ſtreight, did make connexion,
In *X* the node, or focus of that ſection:
But being ſtreightly hedg'd, the laſt great flood
Drove all that mound from off the ground it ſtood,
Left nothing ſtanding but a willow tree,
And that, by chance, grow'd in the vertex *C*.

Since

Since which all ways are try'd for to regain
The points *M*, *X*, but all, alas ! prove vain.
But this may useful be, the side *CX*
Was found, before the flood, poles twenty-six ;
The square of which, they say, was equal to
The meadow's area.   Now we beg of you
To give the side *XM*; for till that's found,
We can't again pretend to fix the ground.

V. *Question* 133, *by* Τελώνης Πάλαι.

Ye charming fair sex, to whom benign heav'n
A bright and superior genius hath given;
Whose luster in wit and art does appear,
In the bright annals of the rolling year;
Your aid's much desir'd : And you, sons of art,
Your kind affistance pray please to impart
To a young Philomath, who labours to find
A right-angled triangle of such a kind,
That when the doubled ale area on every side
In its utmost extent (tho' never so wide)
Being duly subducted, the remainders all three
(From every side) a square number shall be.
    Now, ladies, and artists, pray please to explain,
When a vessel's erected upon such a plane,
At ten inches depth, how much ale 'twill contain.

VI. *Question* 134, *by Mr.* Tho. Grant.

Ye British ladies, to whom all apply,
As an oracle, in things abstruse;
The greatest area that can b' inclos'd
By four right lines, such as below are seen,
Vouchsafe to tell: for surely you, or none,
The deep mysterious secret can reveal.

        [The lines 20, 16, 12, and 10.]

VII. *Question* 135, *by Mr.* John Turner.

In that delightful isle of old so fam'd
For Cytherea's rites, thence Paphos nam'd;
Inclos'd with flow'ry meads, a mountain stands,
That casts a shadow into distant lands:
In vain access by human feet is try'd,
Its lofty brow looks down with noble pride

On fruitful Nile, tho' seven wide channels spread,
And sees old Proteus in his oozy bed:
    Whose altitude if cub'd and multiply'd
Into three times the square root of the side,
Drawn from the mountain's vertex (till it be
A tangent to the earth's convexity,
Bounding the utmost prospect of the view)
Produces what I in the margin shew.   [1005'9309 miles
If now the earth's radius suppofed be
In miles three thoufand nine hundred sixty-three,   [3963
Artifts, the mountain's height explain,
Above the horizontal plain.

The Prize Queftion.

    Bold Britons, boaft no more of Bacchus here,
Since he's dethron'd by Parfon's humming beer;
Straight abdicate him our dominions quite,
And Parfons deify, as 'tis his right.
    Let foreign dregs no more our fenfe invade,
Which robs our ftores, and fpoils domeftic trade:
Champaign, Bourdeaux, and Burgundy no more
Will be efteem'd as they have been before;
His fov'reign, ftout, and fine balfamic ale
Excels that nectar did the gods regale.
For fack no more the learned can infpire
Like this fame beer, with true poetic fire.
'Twill make the courtier hate the fawning knave;
The tim'rous foldier, valorous and brave;
The canting whig, felf-int'reft to defpife;
And heedlefs tories, to become more wife;
Make the mechanic new inventions find,
And will infpire true Britons with one mind.
    Henceforth, renowned Parfons, you fhall be
Efteem'd our patron, own'd a deity.
Your ftately cafk to be your throne, from whence,
To all your votaries, your laws difpenfe.
    This fpheroid cafk, whofe magnitude is fuch,
The Trojan horfe did not contain fo much;
For, by th' dimenfions, it does plain appear ⎫
To hold twice eighty * barrels of ftrong beer: ⎬
Alfo the head's the latus rectum of its fphere. ⎭
If you the diagonal from th' length fubtract,
Two feet two inches then remain exact.
Ingenious artifts, I this favour afk,
To fhew th' dimenfions of this fpacious cafk.

        * 160 barrels at 36 gallons to the barrel.

1729.

Queſtions anſwer'd.

* I. *Queſtion* 130 *anſwer'd by* Mr. Turner.

HAving AC given $= 14$ chains, the angle $ABC = 78°$ and the ratio BA to BC as 4 to 3. It is eaſy to find $BA = 12·51881$, and $BC = 9·38912$. Draw the lines as in the ſcheme, and put

$$DA = b = 6·4,$$
$$Ag = g = 9·4487,$$
$$gC = m = 4·5512,$$
$$gB = h = 8·2123,$$
$$EC = n = 10·1,$$
$$nC = a?$$
$$Ap = e?$$
$$EH = y?$$

Then

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* I. QUESTION 130.

Here being given of the trapezium the three ſides AD, AC, and CE, the angle ABC formed in the other ſide, the ratio (m to n) of its legs AB, BC, and the ratio (p to q) of the ſegments BD, BE of the other ſide; from which the figure will be conſtructed thus:

Conſtruction.

On the given baſe AC (by Prob. 3 of Simpſon's Algebra) conſtitute a triangle ABC whoſe ſides ſhall be in the given ratio of m to n, and whoſe vertical angle ſhall be equal to the given one. Then with the centers A and C, and radii equal to the other two given ſides of the trapezium, deſcribe two circles. Produce CB, and make as $q : p ::$ $CB : BF$ and alſo $:: CE :$ FD; which apply to the circumference of the circle whoſe center is A. Draw DB, and continue it to meet the circumference of C in E; and $ADEC$ is the trapezium required.   *Demon-*

Then $2 : 3 :: m - a : g - e$ per queſtion.
$4bb - 4ee = 4bb - 12by + 9yy$ per Euclid 47. 1.
$9nn - ss - 4se - 4ee = 9bb + 18by + 9yy$:
Putting $s = 3m - 2g$, and $w = 9nn - ss$,
We ſhall have $y = 2b - 2\sqrt{ab - ee}$,

$$\text{and } y = \sqrt{\frac{w - 4se - 4ee}{9}} - b.$$

And reducing the equation, $e = 3^{\cdot}43139$, y is found $=$ $1^{\cdot}87239$, $a = 0^{\cdot}53966$. Hence $BD = 6^{\cdot}6411$, and $BE =$ $4^{\cdot}4274$ chains, and the whole $DE = 11^{\cdot}06850$.

A. R. P.

And the areas of $\begin{cases} ADB = 1 & 0 & 22^{\cdot}7667 \\ ABC = 5 & 3 & 1^{\cdot}3731 \\ CBE = 2 & 0 & 11^{\cdot}7145 \end{cases}$

Mr. *R. Fearnſide*'s anſwer is the ſame in every indivi-dual letter.

II. *Queſ-*

Demonſtration.

The triangles BCE, BFD are ſimilar by Eucl. VI. 7, and therefore $BE : BD :: BC : BF :: q : p$ by the conſtruction; and the reſt is alſo evident from the conſtruction.

Calculation.

As $m + n : m - n ::$ cotang. $\frac{1}{2} \angle ABC :$ tang. $\frac{1}{2}$ dif. of the angles BAC, BCA at the baſe; which added to and taken from half their ſum, we obtain thoſe angles themſelves ;, and conſe-quently the triangle ABC becomes all known, which is one part of the field.——Then in the trapezium $BADF$, are known all the ſides and the $\angle ABF$; to find the diagonal BD; for AD is given, and AB and the $\angle B$ have been found; then by the con-

ſtruction $q : p :: \begin{cases} CB : BF = \frac{p}{q} \times CB \\ CE : DF = \frac{p}{q} \times CE \end{cases}$. To determine

BD, draw AF; then in the triangle ABF, given two ſides AB, BF, and their included $\angle$, to find the third ſide AF and the $\angle AFB$. Then in the triangle ADF, are given all the ſides, to find the $\angle AFD$; and the ſum or difference of AFB and AFD will be the $\angle DFB$. Wherefore in the triangle DFB, are known two ſides DF, FB, and their included angle, and conſequently the whole triangle; which is the 2d portion.——Laſtly, as $m : n$ $:: DB : BE$; hence the 3d portion CBE is known.

II. *Question* 131 *answer'd by* Mr. Tho. **Grant.**

A ball moving 40 miles the firſt hour, 35 the ſecond, and
ſo on for ever in the ſame ratio, will go 320 miles. Then,
by the queſtion, as 4 : 9 :: 320 : 720 miles = the ſum of
a decreaſing geometrical progreſſion, whoſe ſecond term is
$46\frac{1}{7}\frac{8}{9}$ and laſt term = 0. Let x = the firſt term of the
ſame; then, per Euclid 5. 12, 'twill be as $x : 46\frac{1}{7}\frac{8}{9} :: 720 :$
$720 - x$. This, turned into an equation, gives $720x - xx$
$= 33500$; whence $x = 50$ miles, and the common ratio as 6
to $5\frac{7}{11}$ or as 1 to $\frac{67}{72}$. *Q. E. I.*

III. *Question* 131 *answer'd by* Mr. Turner.

If a line of 30 cubits, or 656.64 inches, would ſurround
the molten ſea on the outſide; then the outſide diameter
was but — — — — 209.015 inches

Twice the thickneſs of the
copper or 2 hand br. ſub. $\Big\}$ — 7.296

Remains the inſide diameter — 201.719

The depth 109.44 inches, area
of the baſe $\Big\}$ 34311.982

The whole ſolid content from
outſide $\Big\}$ 3755103.31 cubic inches

Add the copper's bottom — 125170.11
The ſum is — — — 3880273.42
Content of the inſide — — 3497523.126
Difference — — — 382750.294
Equal to the cubic inches of copper. Divide the laſt ſum
but one by 2000, the number of baths it contained, gives
the quotient 1748.76 cubic inches the content of one bath
= $7\frac{6}{10}$ gallons wine meaſure; the whole contained 15140.8
gallons wine meaſure, or 60 tuns 20 gallons. Then accord-
cording to Mr. Ward,

A cubic inch of $\Big\{$ copper weighs 5.208369 $\Big\}$ ounces avoird.
clear water 0.578697 $\Big\}$

Hence the weight of $\Big\{$

	water	56 tuns	8 hund.	12 pounds
water	56 tuns	8 hund.	12	pounds
copper	55	12	40	13
on the oxen 112	0	52	13

Q. E. I.

Anfwer'd by Mr. John Clark.

By Harris's Lexicon a $\begin{cases}\text{cubit is} & 21\text{·}888 \text{ inches}\\ \text{palm} & 3\text{·}648\\ \text{bath} & 1747\text{·}700\end{cases}$

whence the quantity of 2000 baths 3495400
water in the fea 3497504
difference 2104, which is but
$\frac{6}{100}$ of an inch in the depth, or little more than one bath.

                                 T. c. ft. lb.dw.·gr.

Then by Mr. Boyle's $\begin{cases}\text{of water is} & - & 57 \ 0 \ 5 \ 11 \ 205 \ \ 8\\ \text{fides of the copper} & 37 \ 2 \ 7 \ \ 4 \ \ 59 \ 16\end{cases}$
proportion the wt.
and the bottom in proportion to the fides 18 1 0   1 173 9
The whole weight in avoirdupois   —   112 4 5   4 146 9

      * IV. *Queftion* 132 *anfwer'd by* Mr. W. Milward.

Let fall the ordinate MP, which call a, and put $CX = b = 26$ poles.

As $4b : a :: a : \frac{aa}{4b} = CP$ per-conics.

$\frac{2CP \times PM}{3}$ = the area of the femi-parabola $CPM = \frac{2aaa}{12b}$ or $\frac{aaa}{6b}$.

$CX - CP = PX = \frac{4bb - aa}{4b}$, and

$PX \times \frac{1}{2} MP$ = the area of the triangle PXM.

The $\triangle PXM$ + area of the femi-parabola = the area of the meadow, viz. $\frac{aaa}{6b} + \frac{4bba - aaa}{8b} = bb$ per queftion.

$aaa + 12bba = 24bbb$; here a is $= 42\text{·}55$ poles. Hence $MX = 43\text{·}445.$

                                  V. *Quef-*

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      * IV. QUESTION 132.

Putting $b = CX$, and $x =$ the ordinate PM; then, by the nature of the parabola, $CP = \frac{x^2}{4b}$; and, by prob. 7 page 321 Menfuration, $\overline{CX + \frac{1}{3}CP} \times \frac{1}{2} PM =$ the area $= b^2$ by the queftion; that is, $\overline{b + \frac{x^2}{12b}} \times \frac{1}{2} x = b^2$, or $x^3 + 12 b^2 x = 24 b^3$.

* V. *Queſtion* 133 *anſwer'd by Mr.* Geo. Brown.

Let $a =$ ſide of the triangle ; then $\frac{2aa}{282} =$ the double

area. And ſuppoſe $a - \frac{2aa}{282} = 4$; which will admit of

many anſwers, for when brought to a ſolution it will be
$a - 70.5 = \sqrt{4970.25 - 564}$, and the greateſt root take
to be the utmoſt extent mentioned, viz. $a = 705 + \sqrt{4970.25 - 564} = 136.879$. And making this equation for

the other ſide $a - \frac{2aa}{282} = 2.25$; then $a = 138.71$. And a
veſſel erected upon ſuch a plane, at 10 inches deep, contains
334.49 ale gallons.

† VI. *Queſtion* 134 *anſwer'd by Mr.* Tho. Grant.

Let $x = BD$, $a = AD$, $b = AB$, $c = CD$, and $d = BC$.
      1. By the figure,

$x : a + d :: a - d : \dfrac{aa - dd}{x} =$
$DF - BF$, therefore
$DF = \dfrac{xx + aa - dd}{2x}$.

      2. Again by the figure,

$x : c + b :: c - b : \dfrac{cc - bb}{x} =$
$DE - BE$, therefore $DE = \dfrac{xx + cc - bb}{2x}$.
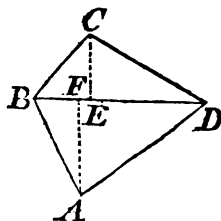
      3. By

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* V. QUESTION 133.

It is not clear what is meant by this queſtion as it is worded ; if
double the area of the triangle is to be taken from each ſide, and
the three remainders are to be ſquares, then ſolutions are given at
queſtion 638.

† VI. QUESTION 134.

By Theorem 12 of Simpſon on the Max. and Min. of Geometrical
Quantities, the trapezium will be greateſt when it can be inſcribed
in a circle ; and then, by rule 5 page 72 of my Menſuration, the
area will be found thus : Half the ſum of the given ſides is 29,
from which each of the ſides being taken, we have the four re-
mainders 9, 13, 17, 19 ; and the area $= \sqrt{9 \times 13 \times 17 \times 19} = 194.4$.

3. By Eucl. I. 47.

$$\sqrt{\dfrac{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}{4xx}} = FA.$$

4. By the same,

$$\sqrt{\dfrac{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4}{4xx}} = EC.$$

5. By the figure,

$$\overline{\tfrac{1}{4}\sqrt{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}} +$$
$$\tfrac{1}{4}\sqrt{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4} = \text{the}$$
greatest area.

6. The last in fluxions,

$$\dfrac{a^2x\dot{x} + d^2x\dot{x} - x^3\dot{x}}{2\sqrt{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}} +$$
$$\dfrac{c^2x\dot{x} + b^2x\dot{x} - x^3\dot{x}}{2\sqrt{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4}} = 0.$$

7. This reduced is

$$-x^8 \begin{cases} +2a^2 \\ +2b^2 \\ +2c^2 \\ +2d^2 \end{cases} x^6 \begin{cases} -a^4 \\ -b^4 \\ -c^4 \\ -d^4 \\ -4a^2b^2 \\ -4a^2c^2 \\ -4b^2d^2 \\ -4c^2d^2 \end{cases} x^4 \begin{cases} +2a^2b^4 \\ +2a^2c^4 \\ +2a^4b^2 \\ +2a^4c^2 \\ +2b^2d^4 \\ +2b^4d^2 \\ +2c^2d^4 \\ +2c^4d^2 \end{cases} x^2 \begin{cases} -b^4a^4 \\ -b^4d^4 \\ -c^4d^4 \\ -c^4a^4 \\ +4a^2b^2c^2d^2 \end{cases} = 0.$$

8. Or in numbers

$$-x^8 + 1800x^6 - 1076272x^4 + 222272000x^2 - 8768000000$$
$$= 0.$$

Hence $x = 21\cdot187$. And the greatest area is $194\cdot4$, &c.

VII. *Question* 135 *answer'd by* Mr. John Bulman.

Let $x = BA =$ the mountain's height.
Then $x + 3963 = AC.$
Hence $xx + 7926x + 15705369 = AC^2.$
Or $xx + 7926x = AM^2.$

See Fig. to
Quest. 101
p. 244.

Consequently $\sqrt[4]{81x^{14} + 642006x^{13}} = 1005\cdot9309.$
Then if the latter part of the equation at the last step be
involv'd to the fourth power, and the radical sign taken
away from the first part, the equation will be clear of surds,
and x may be found $= 3$ miles, the mountain's height re-
quired.

E e 2   The

The same answer'd by Mr. R. Fearnside.

Put $a = AB$, $b = CB = 3963$, $e = AM$, $c = 1005\cdot93c9$.
Then $3a^3\sqrt{e} = c$, and $e = \dfrac{cc}{9a^6}$. Then $ee = 2ba + aa$

$= \dfrac{c^4}{81a^{12}}$, or $a^{14} + 2ba^{13} = \dfrac{c^4}{81}$; reduced, $a = 2\cdot999999$
miles.

The Prize Question answer'd by Mr. Geo. Brown.

Let $AC = a$, $CE = LD = x$,
$EE - AD = b = 26$ inches, $d =$
5760 the content, $c = 1077\cdot15$.
$4xx - 4bx + bb = AD^2$.

$\sqrt{3xx - 4bx + bb} - a = DE$.
$3xx - 4bx + bb + aa -$
$2d\sqrt{3xx - 4bx + bb} = DE^2$.
$12xx - 16bx + 4bb + 4aa -$
$8a\sqrt{3xx - 4bx + bb} = DH^2$.

$\dfrac{24x^3 - 32bx^2 + 8bbx + 24aax - 16ax\sqrt{3xx - 4bx + bb}}{c} = d.$

$24x^3 - 32bx^2 + 8bbx + 24aax - dc =$
$16ax\sqrt{3xx - 4bx + bb}$, and when squar'd $576x^6 -$
$1536bx^5 + 1408b^2x^4 + 1152a^2x^4 - 512b^3x^3 - 48dcx^3$
$- 1536ba^2x^3 + 64b^4x^2 + 64bdcx^2 + 384b^2a^2x^2 +$
$576a^4x^2 - 16dcx - 48dca^2x + d^2c^2 = 768a^2x^4 -$
$1024ba^2x^3 + 256b^2a^2x^2$.

And when aa is found in the unknown quantity x, there
will be an equation of the 12th power affected; from whence
the length is $156\cdot2$, diagonal $130\cdot2$, bung diameter $128\cdot3$,
and head $82\cdot1$. *Q. E. I.*

Others have answer'd it as below.

	Length	Diag.	Bung	Head
Mr. *John Bulman* — —	$157\cdot25$	$131\cdot25$	$128\cdot8$	$81\cdot72$
Mr. *James Clarke* — —	160	134	127	88
Mr. *John Rosser* — —			$126\cdot01$	$76\cdot5$
Mr. *John Finch* — —	157		$128\cdot19$	$81\cdot5$
Mr. *John Side-Bottom* —	163	137		$81\cdot5$
Mr. *John Hampson* — —	157		128	81

The lot of 10 diaries fell to Mr. J. Finch, of Worcester.

O

Of the Eclipses in 1729.

There will be five eclipfes this year : Three times will the dark body of the moon interpofe between the fun and our earthly globe; and twice does the earth come between the fun and the moon, and hinder his rays from enlightning the moon.

1. Sun eclipfed on Saturday the 18th of January, at 6 in the morning, invifible to us by reafon the fun is not rifen.

2. Moon eclipfed on Candlemas-day, the 2d of February, at 3 quarters after 8 at night, total and vifible.*

	Begin.	Begin. tot. da.	Middle	End of tot. da.	End	Dura.	Digits
Aftron. Carol. } Coventry }	VII 4	VIII 3	VIH 50	IX 37	X 36	III 32	19 30
Chattock, Lond.	7 0	8 1	8 52	9 44	10 45	3 44	20 0
Leadbetter, dit.	6 57	7 58	8 44	9 30	10 31	3 33	19 17
J. Newton, Fl. } Ta. Melt. }	7 4	8 4	8 53	9 41	10 41	3 37	19 46
J. Bulman, Roch.	7 12	8 11	8 38	9 45	10 44	3 32	19 31
Urania, N.Pag.	6 55	7 55	8 40	9 55	10 25	3 30	10 20

3. Sun eclipfed the 16th day of February, at 9 at night, but invifible, the fun being then fet.

4. Sun eclipfed on the 15th of July, invifible, being at 1 in the morning, when the fun is below our horizon.

5. Moon

* This eclipfe was obferved thus :

Place	Obferver	Beginning	Tot. Im.	Emerfion	End
		h. m. s.	h. m. s.	h. m. s.	h. m. s.
Near Car- } ricfergus } in Irela. }	A. Dobbs } Efq. }	6 29 30	7 30 15	9 8 30	App. Time
Rome —	J.B.Carbone	7 44 22	8 43 17	10 21 38	11 20 41 tr.
Paris —	— —	7 3 0		9 41 18	10 41 24
Pekin —	— —	14 38 30	15 39 0	17 17 10	18 17 40

5. Moon eclipfed, total and vifible, with continuance, on Tuefday the 29th of July, at 1 in the morning.*

	Begin.	Beg.to dark.	Mid.	End to dark.	End	Durat.	Digits
Aftron. Carol. } Coventry }	XI 15	0 14	I 1	I 48	II 47	III 32	19 5
Leadbetter, Lond.	11 33	12 33	1 19	2 5	3 5	3 32	18 47
Chattock, Covent.	11 19	12 20	1 11	2 2	3 3	3 44	19 45
J. Newton, Mel. } Moberry }	11 14	12 14	1 3	1 51	2 51	3 37	19 13
J. Bulman, Roch.	11 22	12 21	1 8	1 55	2 54	3 32	19 7
Urania, Newport	11 34	12 35	1 20	2 5	3 6	3 32	19 20

New Queſtions.

I. *Queſtion* 136, *by Mr.* John Bulman.

When grateful heaven did on Henry ſmile,
The ſeventh of that name who rul'd this iſle,
The mighty monarch (with an awful hand)
Two courtiers (known for treafon) did command
That one to Yoik, thrice fifty miles in length
From London; the other he to Stilton ſent
From thence; (which places north of London lay)
They ſhou'd from the fame moment take their way.
From thence a journey of a week they went,
Directly north, as by the King's confent:
Between the foremoſt man and London found,
By the laſt trav'ler, the fpace of ground,
Muſt in extreme and mean ratio run
As well at laſt, as when it firſt begun.

                                                                    By

* This eclipfe was obferved thus:

Place	Obferver	Beginning	Tot. Im.	Emerfion	End
		h. m. s.	h. m. s.	h. m. s.	h. m. s.
Wirtemb.	J. Weidler	12 1 30	13 1 0	14 40 30	15 40 0
Rome	—— ——	12 1 0	13 0 16	14 38 24	15 38 0
Padua	J. Poleni	12 0 28	12 58 48	14 31 38	15 38 ₑₐₚ.t.
Bononia	E. Manfredi	11 56 54	12 55 52	14 34 25	15 35 oɪɪ.ɪ
Barbado.	Mr Stevenfon	— — —	8 11 0	9 51 0	10 50 oₐₚ.ɪ

By Stilton then alfo the diftance fhall
Be in extreme, and mean proportional,
Between London and York; and to take place
To York, from Stilton is the greater fpace.
  Fair ladies, then tell me by algebra,
Th' ratio of the fwiftnefs of their way,
And from London to Stilton tell I pray.
And from York to Stilton 'tis intended
The miles to know, and this work is ended.

II. *Queftion* 137, *by Mr.* John Simmons.

The wine gallons that each body platonic will hold,
(The fides twenty-nine inches) fome years fince was told.
A wager is laid me, were each fide an inch more,
'Twould puzzle my noddle, the fame to explore.
I've try'd many ways, but in vain, for I find
My money is loft, if not help'd by fome friend,
On whofe fkill, in the cafe, I may fafely depend.
Now, gentlemen gaugers, pray fhew me your art,
And in the next Diary be pleas'd to impart,
What each body wou'd hold, were a globe in its belly
(The ambient fides touching;) and alfo pray tell me
The number of gallons each fphere will contain,
That wou'd nicely inclofe each body — make plain.

III. *Queftion* 138, *by Mr.* Tho. Grant.

When Argo, fraught with the inchanted prize,
With Grecian heroes, and with Medea wife,
Had weigh'd her anchor, and her canvas fpread,
A golden apple at the fore-maft-head
Sublime they place; their vict'ry to proclaim.
They fail in triumph o'er the paffive main,
With equal pace; when, by mifchance, the ball
In three half feconds to the deck did fall;
During which time they plow the yielding deep,
The length of five and twenty Grecian feet.
  Now tell me, ladies, who have arts at will,
The fpace's length thro' which the trophy fell?

IV. *Question* 139, *by Mr.* Tho. Williams.

Not far remov'd from fam'd Oxford, the eye
And Athens of our British isles, doth lie
A little right-lin'd field triangular,
Whose pregnant mould uberous crops does bear.
This, by a father's will, I must divide
Betwixt two sons, who will not be deny'd;
Because they've heard much of my boasted skill,
How I with ease such problems cou'd fulfil:
For I am apt to talk more than I know,
As most conceited fools are wont to do.
Now, to distinguish angles, we will call
Them A, B, C, in manner as they fall:
A, that is known; the side AB is giv'n;
One eighty-two degrees, t'other chains thrice sev'n:
From A the parting fence must go to D,
Cutting the angle A, and side BC,
That BAD, to DAC, may in
Proportion be, as twelve is to eighteen:
And that BD to DC, may also
Be in the ratio just of three to two.
Hence, I'm to shew what lengths each side will bear,
And how much land will fall to each son's share.
I know it may be done, but cannot do't,
Nor will my boasted rules here help me out;
So, ladies, with submission I implore
Your aid this once, and I will ask no more:
For you or none (whose wits so bright appear)
Can keep my credit up, now lost so near.

V. *Question* 140, *by Mr.* John Lowe.

Suppose there be a pyramid erected upon a triangular
base, whose longest side is eighty-eight inches, and the
angle opposite to the longest side is eighty-five degrees and
one minute, and the rectangle of the other two sides added
to their sum is four thousand one hundred and three inches;
and the pyramid's greatest angle of altitude, is in proportion
to its least, as seven is to six: What is the difference, in ale
gallons, betwixt the greatest cylinder and sphere that may
be inscribed in the said pyramid?

VI. *Question* 141, *by Mr.* Will. Browne.

What three numbers are thofe, ladies, do you fuppofe,
    That the fquare of the firft, and indeed,
The rectangle of the firft and the fecond may juft
    Make the fum of a fcore, is agreed?
And the fecond, you muft know, being fquar'd, as you go,
    And the product of the fecond and third,
Will make a whole fcore, and half a fcore more,
    When added, I'll give you my word.
And the third, pray regard, when as it is fquar'd,
    And the firft in the third multiply'd,
The fum will make out, two fcore, without doubt,
    Algebra will fhew you, when try'd?

VII. *Question* 142, *by Mr.* John Ingleborough.

The great tun at Heidelberg, an author fays, held as much
wine in its entrails as the Coloffus of Rhodes held water be-
tween its thighs. It is 31 feet long, and 21 high.
    Now fuppofing the tun to be of the fame fhape with Par-
fons's cafk, mentioned laft year, fo far as may agree with
the dimenfions above; how many gallons of wine wou'd it
contain? Secondly, fuppofing Parfons's cafk of ftout to equi-
ponderate with the Heidelberg tun of wine, fufpending from
a ballance 60 feet long; what wou'd the difference of the
brachia of the balance be? And thirdly, fuppofing it were
requir'd that each veffel fhou'd evacuate itfelf exactly in two
hours by a hole in the loweft place; what muft the diameter
of each bore be, that fo the veffels may hang in equilibrio
all the time the liquor is running out, not admitting the
weight of the veffels to interfere or make any variation?

The Prize Question.

A certain courier being at Montpelier,
    (So fam'd for its excellent fpaw)
Ere that place he leaves, an order receives,
    Exprefs unto Turin to go.
Now its very well known, that the river of Rhone,
    Which betwixt the two places doth lie,
Runs due north and fouth, quite down to its mouth,
    Through Provence and through Dauphiny:

Mont-

Montpelier, 'tis manifeft, lies forty miles weft,
  And no more, from the river of Rhone;
And Turin is plac'd one hundred and fifty due eaft,
  From the fame, as with eafe may be fhown.
Likewife the true fpace, from that to this place
  (Becaufe that we ought to define)
Is two hundred miles juft*, (if fame we may truft)
  When meafur'd upon a ftreight line.
Now the gentleman knows, that as long as he goes
  On the weftern fide of the river,
It is in his power, to ride three miles on hour,
  If he but exert his endeavour.
But on the orient he muft be content,
  (When he has done all in his power,
It being a tedious and troublefome way)
  To take up with two miles an hour.
Now, ladies, difcover, the point to pafs over,
  That the river fuch wife may be croft,
That he may profecute his journey throughout,
  And the feweft of moments be loft?
That's, what may be the intermediate fpace
From the faid point to each refpective place.

<center>* 200 miles from Montpelier to Turin.</center>

1730.

Queftions anfwer'd.

I. *Queftion* 136 anfwer'd by *Mr.* Rob. Fearnfide.

THE diftance between York and London given 150 miles;
from London to Stilton will be eafily found 57·2949
miles; and Stilton to York 92·7051. Put $y =$ the fpace
                                                    paffed

<center>* I. QUESTION 136.</center>

The meaning of this queftion is, To divide 150 miles into two
parts in extreme and mean proportion; and to find the ratio of the
equable velocities, by which the lefs part and the whole length
may be paffed over in the fame time.

paſſed over by the courtier bound to Stilton, in any moment of time; and $x =$ the ſpace paſſed over by him bound for York in the ſame moment of time. Then, per queſtion, $xx - 2xy + yy = xy$, in fluxions $2x\dot{x} - 3x\dot{y} - 3y\dot{x} + 2y\dot{y}$ $= 0$. Reduced to an analogy, $\dot{y} : \dot{x}$ (the fluxion of any flowing quantity being taken for its velocity) $:: 2x - 3y :$ $3x - 2y$. That is, as 128·1242 to 335·4161.

II. *Queſtion* 137 *anſwer'd by* Mr. Tho. Grant.

Names of the bodies	Capacities	Inſcrib'd ſpheres	Holds beſides the ſpheres	Ambient ſpheres content
	Win. gall.	Win. gall.	Win. gall.	Win. gall.
Tetrahedron	13·77	4·16	9·61	112·43
Hexahedron	116·88	61·20	55·68	318·00
Octohedron	55·09	33·08	22·01	173·09
Dodecahedron	895·69	676·00	219·69	1347·09
Icoſahedron	255·00	211·34	43·65	421·17

Mr.

Put $x =$ the leſs part, and $a = 150$ the whole. Then $a - x$ $=$ the greater part; and, by the queſtion, $x : a - x :: a - x : a$; hence $ax = a^2 - 2ax + x^2$, and $x = \frac{3 - \sqrt{5}}{2} \times a =$ the leſs part. Therefore $a - x = \frac{\sqrt{5} - 1}{2} \times a =$ the greater part.——Hence

The two parts of any quantity which is divided into extreme and mean proportion, are in the ratio of $\frac{3 - \sqrt{5}}{2}$ to $\frac{\sqrt{5} - 1}{2}$, or of $3 - \sqrt{5}$ to $\sqrt{5} - 1$, or of 1 to $\frac{\sqrt{5} + 1}{2}$, or of $\frac{\sqrt{5} - 1}{2}$ to 1.

And the leſs part to the whole, as $\frac{3 - \sqrt{5}}{2}$ to 1; which is the ratio of their velocities or rates of travelling required.

* II. QUESTION 137.

In the *Scholia* at page 403, &c. of my Menſuration, the true values of the content of each regular ſolid, with that of the radius of the inſcribed and of the circumſcribed ſphere, are expreſſed in terms of the linear edge or ſide; whence the numbers, as above, may be eaſily found.

Mr. *Grimmet*, Mr. *Hurd*, Mr. *Bulman*, Mr. *Sidebottom*, Mr. *Colbourn*, Mr. *Brooke*, Mr. *England*, Mr. *Brown*, Mr. *Bruin*, Mr. *Sparrow*, Mr. *Lovat*, Mr. *Eyre*, Mr. *Fairchild*, Mr. *King*, Mr. *Armstrong*, Mr. *Battersbee*, Mr. *Hale*, Mr. *Mason*, and several others, answer'd this question.

* III. *Question* 138 *answer'd*.

The ball descending with a compound force, that is, an horizontal force by the motion of the ship, and by the force of gravity; the spaces described by such motions are analogous to the abscissas and their respective semi-ordinates, in the conic parabola, and the motion will be in the curve of the same.

Then there is given the abscissa $= x = 434\cdot25$ inches $=$ the space described in three half seconds by the force of gravity only; and its semi-ordinate $= y = 25$ Grecian feet $= 302\cdot1$ inches English. Whence by fluxions

$$x + \frac{5y^2}{8x} + \frac{3y^4}{128x^3} - \frac{3y^6}{256x^5} + \frac{y^8}{2048x^7} \&c. = 567\cdot42 \text{ inch.}$$

or $47\cdot285$ feet, the space the ball descended.

IV. *Quef-*

* III. Q U E S T I O N 138.

The 25 Grecian feet are $= 25 \times 1\cdot007$ or $25\cdot175$ English feet $=$ the horizontal motion, or the ordinate of the parabola, which call $2y$; and as $1^2 : \frac{1}{4}^2$, or as $4 : 9 :: 16\frac{1}{12}$ feet : $36\frac{3}{16}$ feet $=$ the perpendicular descent; or the abscissa of the parabola, which call x. Then, by Cor. 1 page 310 of my Mensuration, the true length of the curve will be $\sqrt{x^2 + y^2} + \frac{y^2}{x} \times$ hyp. log. of $\frac{x + \sqrt{x^2 + y^2}}{y} = 45\cdot9578$ feet $=$ the length of the line described *by the ball.*

* IV. QUESTION 139 *anſwer'd by Mr.* Rob. Fearnſide.

Put $AB = 21$ chains $= b$, the natural ſine of the angle BAC (the radius being an unit) $= 82° = 0.990268 = t$, the natural ſine $\angle CAD = 49° 12' = .756995 = s$; and $BC = e$.

Then as $e : t :: b : \dfrac{bt}{e} = $ ſine

$\angle ACD$. Again, as $s : CD \left(= \tfrac{1}{3} e\right)$

$:: \dfrac{bt}{e} : AD = \dfrac{2bt}{ss} = 10.988$. On

AC let fall the perpendicular Bp. And ſay as $b : 1 :: t : Bp = 20.795$. Conſequently Dd is $= 8.318 = \tfrac{2}{5} Bp$, $CD = 13.1837$, the area of the $\triangle ACD$ $= 4.166$ acres, and of the $\triangle ADB$ is $= 6.249$ acres.

V. QUES-

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* IV. QUESTION 139 *calculated otherwiſe.*

The $\angle BAD = \tfrac{2}{5}$ of $82° = 32° 48'$, whoſe ſine call a; and $\angle CAD = \tfrac{3}{5}$ of $82° = 49° 12'$, whoſe ſine call s; alſo $t = $ s. $\angle BAC$ or $82°$, and $b = AB = 21$ chains as above. Then, alſo as above, $AD = \dfrac{2bt}{ss} = 10.9885$: And hence $\tfrac{1}{2} AB \times AD$

$\times$ s. $\angle BAD$ or $32° 48' = \dfrac{abbt}{ss} = 62.502$ ſquare chains $=$ 6.2502 acres $= \triangle ABD$.

Again, as $AB + AD : AB - AD :: \cot. \tfrac{1}{2} \angle BAD$ or cot. $16° 24' : \text{tang.} \dfrac{\angle ADB - \angle B}{2} = 45° 5'$; which added to $73° 36'$ half the ſum of theſe two angles, we have $118° 41' = $ the $\angle ADB$; and this taken from $180°$, there remains $61° 19'$ for the $\angle ADC$. Then, as s. $\angle BDA : $ s. $\angle BAD :: AB : BD$ $= 12.967$; the 2-3ds of which is $DC = 8.645$. Hence $\tfrac{1}{2} AD \times$ $\times DC \times$ s. $\angle ADC = 41.648$ chains $= 4.1648$ acres for the other part ACD. And, laſtly, as s. $\angle CAD : $ s. $\angle D :: CD$ $: CA = 10.0135$.

Conſtruction.

Having drawn the given ſide AB, and the lines AD, AC making the given angles BAD, DAC; in BA produced take AE to AB in the given ratio of CD to DB, that is, of 2 to 3; draw EC parallel to AD; laſtly draw CB, and it is done.

For, by ſim. $\triangle$s, $AB : AE$ $:: BD : DC.$ F f

V. QUESTION 140 *answer'd by Mr.* Lowe *the proposer.*

Put $AB = b$, the sine of the angle $ACD = s$, its cosine $= c$, $4103 = p$, $AC = a$, and $BC = e$; the radius $= 1$. As $1 : a :: s : sa = AD$; and $1 : a :: c : ca = CD$: but $ae + a + e = p$; hence $e = \dfrac{p-a}{a+1}$, and

$$\dfrac{p-a}{a-1} - ca = BD = \dfrac{p-a-ca^2-ca}{a+1} :$$

Put $1 + c = x$, then $\dfrac{p-xa-ca^2}{a+1} = BD$. Hence $\dfrac{c^2a^4 + 2xca^3 - 2pca^2 + xxaa - 2pxa + pp}{aa + 2a + 1}$

$+ ssaa = bb$. Which equation reduced gives $a = 75$; and thence $e = 53$.

For the pyramid's altitude. The radius of the inscribed circle is $18\cdot3315$ inches $= r$. And $Ac = 57\cdot97468$ inches $= b$; $a =$ pyramid's height $= Ec$. Then $\sqrt{aa + rr} = Ee$ the lesser hypothenuse, and $\sqrt{aa + rr}$ $1 :: a : \dfrac{a}{\sqrt{aa + rr}} =$ the sine of the greater angle of altitude. Then $7 : 6 ::$ $\dfrac{a}{\sqrt{aa + rr}} : \dfrac{6a}{7\sqrt{aa + rr}} =$ the sine of the least angle of altitude; also $\dfrac{6a}{7\sqrt{aa + rr}} : a :: 1 : \frac{7}{6}\sqrt{aa + rr} = AE$ the greater hypothenuse. And $aa + bb = \dfrac{49aa + 49rr}{36}$; which gives $a = 89\cdot6712$ the pyramid's height.

The height of the greatest cylinder is found $= 29\cdot8904$, being 1-3d of the pyramid's height, the content $49\cdot733$ ale gallons; the diameter of the sphere $30\cdot5012$, the content $52\cdot687$ ale gallons; the difference $2\cdot953$ ale gallons.

VI. Question 141 *answer'd by Mr.* Lovatt.

This queftion may be found in Mr. Kerfey's Algebra, p. 299. We have given $aa + ae = 20$, $ee + ey = 30$, and $yy + ya = 40$; which will give $\sqrt{40 + \frac{1}{4}aa} - \frac{1}{2}a$ $= \dfrac{70aa - 400 - a^4}{20a - aaa}$; and reduced is $a = 3\text{\textquoteright}051$, $e = 3\text{\textquoteright}526$, $y = 4\text{\textquoteright}98$.

* VII. Question 142 *answer'd by Mr.* Rich. Lovatt.

The length 372 inches $= d$, bung diameter $= 252 = b$. If the cafk be the fame fhape as Parfons's, the head is the latus rectum; then $\sqrt{dd - bb} : b :: b : 141\text{\textquoteright}334 = $ the head per conics: finding an infinite number of ordinates 'twixt head and bung, will conftitute the folidity $= 59780\text{\textquoteright}4$ wine gallons, and a mean of all thofe ordinates will give an equal cylinder $= 217\text{\textquoteright}3072$ inches. A gallon of wine weighs $8\text{\textquoteright}29645$ pounds avoirdupois. Then $8\text{\textquoteright}296 \times 59780\text{\textquoteright}4 = 495965\text{\textquoteright}1593604$, the whole weight. A gallon of ftout weighs $10\text{\textquoteright}25$ pounds avoird. $\times 5760 = 59040$, the weight of the liquor in Parfons's oafk. Then as the fum of the weights is to the difference, fo is the length of the balance to the difference of brachia $= 47\text{\textquoteright}2348$ feet. From Parfons's cafk the liquor flows $128\text{\textquoteright}8$ inches, equal bung diameter, in $34\text{\textquoteright}218$ thirds of time, Heidelberg cafk flows 252 inches in $47\text{\textquoteright}863$ thirds. Then put $d = 432000$, the thirds in 2 hours, $n = 34\text{\textquoteright}218$, $a = $ the drain of the bore in Parfons's cafk. And then $\dfrac{128\text{\textquoteright}8\,daa}{359\text{\textquoteright}05\,n} = 5760$; hence $a = 1\text{\textquoteright}127$ inch. And by the fame way the bore is found $2\text{\textquoteright}78119$ inches in Heidelberg cafk. Mr. *Tho. Grant* makes the bores $3\text{\textquoteright}387$ and $1\text{\textquoteright}3518$ inches.

The

* VII. Question 142.

The dimenfions of the apertures, as determined in the folution to this queftion, may perhaps be pretty near the truth: but as for the *mathematical* certainty, there does not feem to be a poffibility of it in the cafe.

* *The* PRIZE QUESTION *answer'd by* Mr. John Fearnside.

Put $AB = c$, $CD = d$, $BC = b$, and $CE = b - x$. Then, per 47 Euc. 1. $AE = \sqrt{cc + xx}$; and $DE = \sqrt{dd + bb - 2bx + xx}$. Then, by the question, $2 : 1 ::$ $\sqrt{dd + bb - 2bx + xx} :$ $\sqrt{\dfrac{dd + bb - 2bx + xx}{4}}$, and
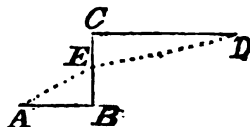
$3 : 1 :: \sqrt{cc + xx} : \sqrt{\dfrac{cc + xx}{9}}$. Therefore

$\sqrt{\dfrac{dd + bb - 2bx + xx}{4}} + \sqrt{\dfrac{cc + xx}{9}} = 0$: which thrown into fluxions, and reduced, $x = 18.5723$, $CE = 43.8776$, $AE = 44.1015$, and $DE = 156.286$; and the time in going the whole journey 92 hours 50 min. 30 seconds: Which agrees to the ingenious proposer Mr. *Turner*, and several others.

On Candlemas-day last the lot of 10 diaries fell to Mr. *John Bulman* of Lewisham, Kent.

Of

_____

.* *The* PRIZE QUESTION.

This problem may be seen applied to various and very curious purposes in *Hayes*'s Fluxions.

Of the Eclipses in 1730.

In this year will happen five eclipses: three times will the moon's opake body interpose between the sun and earth, and hinder his rays from falling on the inhabitants: and twice will the earth come between, and prevent the sun's enlightening the moon.

1. Sun eclipsed the 7th day of January, between 6 and 7 at night, but invisible to us, because 'tis set.*

2. Moon eclipsed on friday the 23d of January, at 3 in the morning, visible.†

Computed by	Begin. h. m.		Midd.		End		Dur.		Dig.	
By Astronom. Carol. Coventry	III	7	III	0	IIII	53	I	46	2	39
Mr. Chattock, London	2	29	3	42	4	50	2	24	4	24
Mr. Leadbetter, London	2	37	3	33	4	30	1	52	2	53
Mr. J. Darley, Nottingham	3	2	3	56	4	50	1	48	2	45
Mr. J. Bulman, Lewisham in Kent	3	13	4	6	4	59	1	46	2	39
Mr. Wm. Brown, Bridgenorth	3	3	3	56	4	50	1	47	2	38
Mr. Williams, Middleton Story	2	31	3	44	4	51	2	25	4	40
Mr. Christ. Fairchild, Spalding	3	4	4	1	4	58	1	54	3	0
Mr. J. Newton, Melton Moberry	2	31	3	34	4	36	2	5	3	37

3. Sun

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* This 1st Eclipse was observed in *Paragua*, in *South America*, by F. *Bon. Suarez*, thus:

<div style="text-align:center">

True time.
h. m. s.
Beginning 2 52 30 *p. merid.*
8 digits at 4 7 33
0 dig. 30′ — 4 50 0

</div>

The end was not observed because of clouds; it seems to have been at 4 h. 51 m. At about 4 h. 55 m. the disc of the sun was seen entire. The greatest obscuration seems to have been 8½ digits.

† This 2d Eclipse was observed at *Lisbon*, by *P. J. Bapt. Carbone*, thus:

Temp.

F f 3

3. Sun eclipſed on ſaturday july the 4th, at 3 quarters after 3 in the morning. The latter part of which, if the air proves favourable, will be viſible. It riſes eclipſed, near 5 digits, at 3 hours 36 min.*

Computed by	Begin.	Midd.	End	Dur.	Dig.
Aſtronom. Carolina. Coventry	II 52	III 41	IV 32	I 40	5 49
Mr. Chattock (by Sci. Stet.) Cov.	2 36	3 25	4 17	I 41	6 5
Mr. Leadbetter, London	2 36	3 26	4 18	I 41	6 7
Mr. Joſ. Smith, ⎰ London	over bef ⊙ riſe		4 30		4 30
⎱ Conſtantinople		5 9	6 16		11 0
⎰ Macao in Japan	1 14	2 50	4 10	2 56	11 0
Mr. C. Fairchild, Spalding	2 50	3 34	4 32	I 42	4 56
Mr. J. Newton, Melton Moberry	2 40	3 29	4 22	I 42	5 51
Mr. J. Bulman, Lewiſham,	2 23	3 28	4 29	2 6	6 1

The fourth of the moon, july 19th, at 4 aftern. inviſible †

The fifth of the ſun, december 28, at 10 in the morning, inviſible, becauſe of the moon's great parallel of latitude.

New

Temp. Ver. p. merid.

h.	m.	s.	
13	25	0	Incipit penumbra ſenſibilis.
13	40	0	Fit ſpiſſior.
13	58	0	Fit ſpiſſiſſima.
14	3	45	Dubitatur de eclipſis initio.
14	4	32	Nunc certo incipere videtur.
16	4	0	Finis eclipſis.

Duratio eclipſis 4 h. 59 m. 28 s.
Medium eclipſis 15 h. 4 m. 16 s.
Quantitas, dig. 3 min. 20, ad Boream.

* This 3d Eclipſe was obſerved

1. At *Wirtemburg* by Mr. *J. F. Weidler.*
Dig. 4 a 4 h. 50 m. 15 s. Temp. ver. ante merid.
Finis — 5　15　30

2. At *Padua* by Mr. *J. Polenus.*
Dig. 4 a 16 h. 46 m. 12 s. Temp. ver.
Finis — 17　6　8

3. At *Peking* by *F. Ignat. Kegler* and *Andrew Pereyra* the end was obſerved at 2 h. 27 m. 10 s.

‡ This 4th Eclipſe was obſerved thus :

	Begin.	End
At *Chamxo* in Nankin by P. Jac. Simonelli	10 h. 55 m.	12 h. 49 m.
— *Cochinchina* by P. Franc. de Lima —	9 48	11 50

New Queſtions.

I. QUESTION 143, by Mr. Tho. Batterſbye.

There is a right-lined triangle, in which a circle is inſcribed; and in the corners of the triangle are placed three little circles, ſo drawn as to touch the adjacent ſides of the triangle, and the greater circle, whoſe diameters are 484, 441, and 400. It is required to find the ſides of the triangle, and the diameter of the greater circle?

II. QUESTION 144, by Mr. Will. Maſſey.

A painter of ſkill, and much fame in the town,
Had procur'd himſelf work for more hands than his own.
He employ'd an aſſiſtant, to help him in part;
A proficient in every branch of his art.
O'er a glaſs of good wine upon terms they debate,
And the bottle was drain'd while they ſtate and unſtate:
For as plenty of Bacchus's enlivening juice,
Does moſt commonly projects and whimſies produce;
So when that their ſpirits grew warm with the liquor,
Freſh maggots were ſtarted, and fancies flow'd quicker.
They were long in contriving what both ſides cou'd pleaſe,
And at length the propoſals agreed on were theſe:
For a ſingle year's ſervice the man ſhou'd be ty'd;
And for every day that he full was employ'd,
Seven ſhillings per day ſhou'd his wages be paid;
But for all ſuch as thoſe when he reſted or play'd,
He ſhou'd forfeit three ſhillings: The year was compleat,
Neither maſter nor man was in each other's debt.
Now, what time he neglected, fair artiſts, is ſought,
And how much for his maſter in painting he wrought?

III. QUESTION 145, by Mr. Rob. Fearnſide.

Two ſhips A and B, weſt and eaſt from each other,
Were bound to a port that they cou'd not diſcover;
To do which the ſhip A takes her way as below*, (*8 5/12 leag.
Betwixt north and eaſt, but what point do not know,
Till ſhe found the port north (for diſtinction call D)
Of herſelf and the place where ſhe left the ſhip B;
Which ſoon as eſpy'd, the ſhip B anchor weigh'd,
And ſailed due eaſt as is here diſplay'd, (11 8 leagues.
　　　　　　　　　　　　　　　　　　　　　　　But

But defpairing to fee the port *D*, furls her fails,
As other fhips ufe to do when nought avails;
While *A* ploughs the ocean but flowly along,
But by fome chance or other the fpace was unknown,
Tho' her courfe, or the point of the compafs the fame
That fhe fail'd from the very firft place that fhe came:
Till by obfervation *D B*, as before,.
The contrary points of the compafs they bore
Of fhip *A*, who was juft five leagues from the fhore.
And fince I have found that the fpace in the fea
Whence *A* firft fet fail, and the anch'ring of *B*:
(If *D* be made center) includes a fourth part:
Of the mariners compafs; or if with lefs art,.
To thofe who ne'er fail'd, I fhou'd better explain
The diftance, a right angle juft doth contain.
·Now, ladies, the diftance betwixt the port *D*,
And where *A* did firft fail from, as alfo of *B*;
And likewife the courfe of fhip *A* let be known?
And aught in the Indies pray claim as your own.

IV. Question 146, *by Mr.* Tho. Grant.

Ye learned fair, to whofe all-piercing minds
Abftrufeft things are known; be pleas'd to fhow
A gen'ral method, that with equal eafe
May the equation * under-written folve,
Or any other of the fame degree.
$$* \quad x^x = 123456789.$$

V. Question 147, *by Mr.* Tho. Williams.

In thirty-one, the ninth of june,
Happens a fmall eclipfe o'th' moon;
Which to define I don't intend,
When 'twill begin, middle, or end,
Et cætera: but leave fuch matters
To hoghen moghen calculators;
And only here in fhort to tell you,
What I have done, and you've to do:
For having drawn as fhou'd be done,
The mundane fhadow, and the moon,
When fhe is moft immers'd therein,
As likewife when it does begin,
And finding thefe three wou'd explain
The matter that I thought to gain;

I'join'd

I join'd their centers with lines that
Made a rectangle triangulate,
Whose base and perpendicular,
Three minutes made above fourscore;
Likewise hypothenuse and base
Sixteen above fivescore t'an ace.
    Hence, you're to shew each sep'rate side,
How much the terrene shadow's wide;
How much the moon's diameter,
And how much dark of her'll appear?
But one thing more I must disclose,
Lest you shou'd miss, that is, if four's
Added to the perpendicular,
'Twill make the moon's diameter.

VI. QUESTION 148, *by Mr.* Tho. Sparrow.

Come, Athens.sons, shew me how to find the place where
(Betwixt here and the moon) that an unactive sphere,
Depriv'd of all motion shall in equilibro depend;
By those two globes attraction, and neither descend;
    And give an example (if you think it fit)
When the moon is the nearest the orb will admit.

VII. QUESTION 149, *by Mr.* Rich. Lovatt.

Assist, ye muses nine, grant me your aid
To speak in verse, for truly I'm afraid;
My tongue wants eloquence for to declare
How much of praise is due unto the fair.
    If the sun's altitude be thirty-three,
On june the third, and the hour angle be
Equal co-latitude; from whence I pray,
Give me a theorem, with the hour o'th' day.

VIII. QUESTION 150, *by Mr.* John Turner.

There is a meadow in form of a parabola, the abscissa of
which is equal to 40 chains, and the greatest ordinate (that
which bounds the meadow) is 72 chains, from whence the
latus rectum will be found 32·4 chains. It is required to in-
scribe such a parallelogram in this parabola, as that its area
may be greater than the area of any other parallelogram that
can possibly be inscribed in the said parabola, and to give
the analytical investigation of the same?

IX. QUES-

IX. QUESTION 151, by Mr. Chr. Mafon.

In a fair vale where fruitful fields appear,
And Flora's beauties flourifh round the year;
There dwells, and long has dwelt, an aged fire,
Where the fame race fix cent'ries did expire.
There his own land with his own cattle tills;
No weight of wealth, nor poverty he feels;
The wifeman's wifh he makes his higheft aim;
A frugal plenty ftill fupplies the fame.
His youthful years in ufeful arts did fpend,
T' improve his judgment, and inftruct his friend;
That his gen'ration might him ufeful find,
And live to die, as the great God defign'd.
Reclufe from balls, from mafquerades, and court,
Where vice triumphant, with her tools refort;
Defpis'd the town, where fops and cullies roam,
And with his choice fedately ftaid at home.
Now with delight as hoary years arrive,
He fees his fons with emulation ftrive
Who fhall his morals neareft imitate,
Whilft he with problems them does ftimulate,
And they with expectation for his praifes wait.
He well obferves, and warily does praife,
Left he fhou'd ftrife, not emulation raife.
With winning ways he calmly does correct,
Left thro' reproof his council they reject:
As thus the fire, —— ' My fons, I you advife,
' Fair virtue chufe, deluding vice defpife;
' Let the great God with rev'rence be ador'd,
' Be art your fport, and live in one accord.
' To what each genius by nature made,
' Be that his art, his calling, or his trade;
' And then with patience prudently purfue,
' Few years will gain what ages never knew.
' And now, fair youths, with vigour make't appear,
' Which of your brows the paper crown fhall wear:
' Refolve this * quere, which I here propofe;
' Your pious mother's and my age it fhows.

$$\left. \begin{cases} aaae + aaeee = 3800000000 = b. \\ eeea + eeaaa = 4067442500 = c. \end{cases} \right\} \text{ Quere } a \text{ and } e?$$

The PRIZE QUESTION.

Laſt Candlemas-eve, the eclipfe of the moon
Made her talk'd of much more than wou'd elſe have been
Her vulgar admirers all gueſs'd at her nature ;   (done ;
By which it appear'd, they knew nought of the matter :
Some computed her age, but at four weeks juſt,
When a new one was made, 'cauſe the old one was loſt :
Others thought this a coſtly, and waſtable trade ;
And urg'd that new ſtars from the old ones were made ;
But this was retorted with ſquibs, and with jeers,
Can dotted old moons make ſhining new ſtars ?
So whatever one ſaid was oppos'd by another,
Which was likely to make a moſt damnable pother :
When a glover ſtarts up, and thus ſpoke t'her honour,
And after this fort, he commented upon her.
   Good neighbours, the moon is a world I dare ſwear ;
And let any preſume to deny't if they dare :
The great biſhop Wilkins hath prov'd what I ſaid ;
Nay, I'd fetch you his book, if I thought you cou'd read :
Then ceaſe your dull whimſies, and ſtudy with me,
How to ſettle a trade betwixt they and we :
Shou'd we loſe Gibraltar and the port of Mahone,
Pray judge the advantage of a trade to the moon.
The noiſe was ſtreight huſh'd ! a deep ſilence began !
For all gazing ſtood, and admired the man :
Such heads being at work, we need not to fear,
But we ſhall ſoon have ſhips ſailing up in the air ;
And the way, without doubt, moſt eaſy be made ;
And the world of the moon, Great Britain's chief trade.
   But ſome few things I cou'd wiſh, were put in good light,
For informing our factors and merchants aright ;
Which far harder may prove than their tare and their tret,
And if ignorant on't, they nothing may get ;
But their profit and loſs, and terms us'd in books,
When ſcrew'd into metre, but aukwardly looks :
So for want of fit words for to gingle and chime,
I'll quere in profe, and ceaſe my dull rhyme.
   Suppoſe at the time above *A*, *B*, and *C* make a ſtock of
21650 hundred weight, and it's ſold at the moon for 2336193 *l*.
9 *s*. 7 *d*. $\frac{5}{8}$, being ſold at a hundred times more per ton than
it coſt ; and ſuppoſe the price of *A*'s ſtock in pounds be the
ſquare root of the ſtock of *B* ; and the ſtock of *A* and *B*, the
ſquare root of the ſtock of *C*. Quere each man's ſtock and
gain, and the weight of the goods at the moon ; and becauſe
if the ſame goods, at the ſame price, had been ſold at the
globe of Jupiter, the amount had been 9108924 *l*. Quere the
weight at his body alſo ?   Queſtio

1731.

Questions answered.

I. QUESTION 143 *answer'd by Mr.* Rich. Lovet.

Given $\begin{cases} NH = 220^\circ 5 = dd, \\ GC = 242 = nn, \\ FM = 200 = hh, \\ EL = aa, \end{cases}$

Per 47 Eucl. 1, we have
$a^4 + 2aadd + d^4 - a^4$
$+ 2aadd - d^4 = 4aadd$
$= HD^2$, and $\therefore 2ad = HD$.

Again $aa - dd : 2ad ::$
$aa : \dfrac{2a^3d}{aa - dd} = BL.$

Hence $\dfrac{2a^3d}{aa-dd} + \dfrac{2a^3n}{aa-nn}$

$= BP, \dfrac{2a^3d}{aa-dd} + \dfrac{2a^3h}{aa-bb} = BQ, \dfrac{2a^3n}{aa-nn} + \dfrac{2a^3h}{aa-bb}$
$= PQ.$

Or $BP = \dfrac{2a^9d - 2a^3dn^2 + 2a^5n - 2a^3nd^2}{\overline{aa-dd} \times \overline{aa-nn}};$
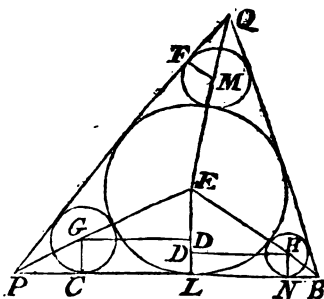
Suppose $\begin{cases} m = 2d + 2n, \\ k = 2n^2d + 2nd^2 : \end{cases}$

And $PQ = \dfrac{2a^5h - 2a^3hn^2 + 2a^5n - 2a^3h^2n}{\overline{aa-nn} \times \overline{aa-bb}};$

Suppose $\begin{cases} c = 2h + 2n, \\ p = 2hn^2 + 2nh^2. \end{cases}$

Hence $\dfrac{BP + PQ + QB - 2PB}{2} \times \dfrac{BP + PQ + QB - 2PQ}{2}$

$= \dfrac{4a^6dh}{\overline{aa-dd} \times \overline{aa-bb}}.$

But $aa + nn : 1 :: aa - nn : \dfrac{aa - nn}{aa + nn} = s. \angle EGD;$

and, by that curious theorem 31 in Spherical Triangles explained by Ozanam, vol. II. p. 142) which holds good in all triangles, we have $\dfrac{a^4cm - aack - aamp + pk}{a^4 - 2aann + n^4}$

$: 1 :: 4dh : \overline{\dfrac{aa - nn}{aa + nn}}^2 ;$

Hence $a^4cm - 4a^4dh - aack - aamp - 8aanndh = 4n^4dh - kp.$ Sub. $b = ck + mp + 8nndh,$ and $l = cm - 4dh;$

Then $aa = \dfrac{b}{2l} + \sqrt{\dfrac{4n^4dh - kp}{l} + \dfrac{bb}{4ll}} = 661 = EL.$
And the lines are $2aa = 1322, \ PB = 2407{\cdot}85, \ B\mathcal{Q} = 2188{\cdot}48, \ P\mathcal{Q} = 2304{\cdot}72.$

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* II. QUESTION 144 *anfwer'd by Mr.* Geo. Anderfon.

Let $b = 365 =$ the number of days in a year, $a =$ the number of days wrought; then $b - a =$ the number of days play'd; therefore $7a = 3b - 3a$ per queftion. Whence a will be found $= 109{\cdot}5$ days wrought; and $255{\cdot}5 =$ the days play'd.

III. QUESTION 145 *anfwer'd by Mr.* Geo. Anderfon.

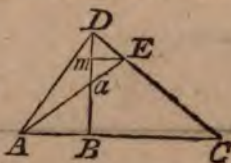Put $Aa = a, \ BC = b,$ and $DA = d.$ Draw mE parallel to $AB,$ and call it $x.$

Per fimilar $\triangle s \ x : d :: b : \dfrac{bd}{x} = CD,$ and $x : d :: \dfrac{bd}{x} : \dfrac{bdd}{xx} = AC;$

Then by 47 E. 1, $\sqrt{\dfrac{b^2d^4 - b^2d^2x^2}{x^4}} = AD.$

Alfo

Alfo $\dfrac{bdd - bxx}{xx} = AB$, $\therefore$ per fimilar $\triangle$s, $\dfrac{bdd - bxx}{xx}$

$$: a :: x : \dfrac{ax^3}{bdd - bxx} = E\,x.$$

By 47 Eucl. 1, we have

$$\sqrt{\dfrac{aax^6 - 2baax^5 \begin{matrix}+ bbaa \\ - bbdd\end{matrix} x^4 + 2bddaax^3 \begin{matrix}+ 2bbd4 \\ - 2bbddaa\end{matrix} x^2 \begin{matrix}- bbd^6 \\ + bbd^4a\end{matrix}}{bbd^4 - 2bbddxx + bbx^4}}$$

$= AD.$

Which being made equal to the above value of it, and the equation reduced, we have

$$aax^{10} - 2baax^9 \begin{Bmatrix}+ bbaa \\ - bbdd\end{Bmatrix} x^8 + 2bddaax^7$$

$$\begin{matrix}+ bbdd \\ - bbddaa \\ + b^4 dd\end{matrix} \Bigg\} x^6 + \begin{matrix}- b^2 d^6 \\ + b^2 d^4 a^2 \\ - 3b^4 d^4\end{matrix} \Bigg\} x^4 + 3b^4 d^4 d^6 x^2 = b^4 d^8.$$

Or in numbers, $x^{10} - 25^{\cdot}6 x^9 + 105^{\cdot}1932 x^8 + 640x^7 +$ $4349^{\cdot}031 x^6 - 64906^{\cdot}085 x^4 + 18016295^{\cdot}945649 x^2 =$ $150135799^{\cdot}54708$, &c.

Which folved, is $x = 4$ leagues.

Therefore $AD = 12$ leag. $=$ dift. fhip A from D,
$\qquad\qquad BD = 9^{\cdot}6 \qquad$ dift. fhip B from D,
$\qquad\qquad BAa = 30^{\circ}\ 28'\ 53''$ the courfe of fhip A.[*]

The propofer of the queftion, Mr. Fearnfide, gives the courfe the fhip took N.E. by N. $\frac{1}{4}\ 35'\ 39''$ N. but the anfwer above agrees exactly with him as to the fcheme and method.

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* III. QUESTION 145.

To render this queftion and its folution plain, it may be remarked that, In the triangle ADC, right-angled at D, having drawn AE and the perpendicular DB, there are given $Aa = 8\frac{5}{14}$ $BC = 12^{\cdot}8$, and $DE = 5$; to find the other parts.

*IV. QUESTION 146 *answer'd by Mr.* Tho. Grant.

There is given $x^x = 123456789 = a.$ Quere x?

Let n be affum'd near the root x, $z =$ their difference, and $ln =$ the hyperbolic logarithm of n: Then $n \pm z = x$, and (per fluxions) its hyp. $\log. = ln \pm \dfrac{z}{n} - \dfrac{z^2}{2n^2} \pm \dfrac{z^3}{3n^3} - \dfrac{z^4}{4n^4} \pm \dfrac{z^5}{5n^5}$, &c. this multiplied by $n \pm z$ gives $nln \pm z \pm z ln + \dfrac{z^2}{2n} \mp \dfrac{z^3}{bn^2} + \dfrac{z^4}{12n^3} \mp \dfrac{z^5}{20n^4}$, &c. $= la =$ the hyperb. log. of a.

Put $s = 1 + ln$; $d =$ the difference between la and nln; then $sz \pm \dfrac{z^2}{2n} - \dfrac{z^3}{6n^2} \pm \dfrac{z^4}{12n^3} - \dfrac{z^5}{20n^4}$, &c. $= d$; which by inverting the feries becomes $z = \dfrac{1}{s} d \mp \dfrac{1}{2ns^3} d^2 +$
$\dfrac{3+s}{6n^2 s^5} d^3 \mp \dfrac{15+10s+2s^2}{24n^3 s^7} d^4 + \dfrac{105+165s+60s^2+6s^3}{120n^4 s^9} d^5$,
&c. this wrought in numbers gives $n \pm z = x = 8·6400268.$

N. B. The above method will find x to any degree of accuracy by only affuming n nearly $=$ to x, and even without that if the logarithm of a and n be made to a fufficient number of places.
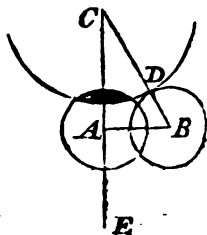
*IV. QUESTION 146.

Though the above be a very complete and mafterly folution, the method of trial-and-error would fooner approximate to the value of the root.

⁕ V. QUESTION 147 *anſwer'd by Mr.* W. Grimmet.

Let $a = AC$ the baſe, $b = AC + AB$ the ſum of the baſe
and perpendicular, $c = AC + BC$ the
ſum of the baſe and hypothenuſe: Then
$b - a = $ the perpendicular; and, per
47 Eucl. 1, $\sqrt{2aa - 2ba + bb} = CB$
the hypothenuſe.   Therefore
$\sqrt{2aa - 2ba + bb} + a = c$: which
equation ſolved, a will be found $=$
54·4985 the baſe, and perpendicular $=$
28·5015, to which add 4 gives the moon's
diameter $=$ 32·5015; and if from the
hypothenuſe $= 61·5015$, be ſubtracted
the moon's ſemidiameter, it leaves CD
$= 45·2508 = $ ſemidiameter of the earth's ſhadow; alſo from
the hypothenuſe ſubtract the baſe, remains the opaque part
of the moon $= 7·0028 = 2$ digits 35′ 7″.

VI. Ques-

⁕ V QUESTION 147.

This queſtion is the ſame as, *In a right-angled triangle, having
given the two ſums of the baſe and hypothenuſe, and baſe and perpendi-
cular; to determine the triangle.* Of which this is the

Conſtruction.

The difference between the two given ſums will evidently be
equal to the difference between the hypothenuſe and the perpendi-
cular: Take EA equal to this difference, and $EAC =$ a mean
proportional between $2EA$ and the greater of the above two ſums;
and AC will be the baſe of the triangle. Then the hypothenuſe
and perpendicular are eaſily found by ſubtraction.

Demonſtration.

Since $CE^2 = \overline{CA + AE}\,^2 = CA^2 + 2CA \times AE + AE^2$
                by Eucl II. 4,
And $AE = CB - BA$ by the conſtruction,
Alſo $AE^2 = CB^2 - 2CB \times BA + BA^2$ by Eucl. II. 7,
We have $CE^2 = CA^2 + 2CA \times CB - 2CA \times AB + CB^2$
                $- 2CB \times BA + BA^2$;
Again $CB^2 = CA^2 + BA^2$ by Eucl. I. 47,
Therefore $CE^2 = 2CB^2 + 2CB \times CA - 2CB \times BA - 2CA \times AB$
                $= \overline{CB + CA} \times \overline{2CB - 2BA}$ (by Eucl. II. 1.)
                $= \overline{CB + CA} \times 2AE$.   Q.E.D.

* VI. QUESTION 148 *answer'd by Mr.* John Fearnside.

Two bodies gravitating towards each other, the diftances of the common center of attraction, are directly as the quantities of matter in the bodies: Whence the quantity of matter in the earth being, according to Sir Ifaac Newton, to that of the moon, as 39·778 to 1. And the mean diftance of the earth and moon = 1271018757 Englifh feet, the diftance required from the earth 215882 miles, and from the moon 59018 miles.

The moon is at her neareft diftance from the earth, when fhe tranfits her perigæon at the moment of her being in oppofition to the fun; and the earth in aphelium; which happens very nearly, (viz.)

	da.	h.	'	"
The moon in perig. 1730, june	18	19	36	31
Full moon — — —	18	21	3	31
Earth in aphelium — —	18	23	51	0

Mr. W. Grimmet, who has anfwer'd this queftion, obferves that there may be different anfwers to the queftion, according to the authors made ufe of for the diftances and magnitudes. Some few of the anfwers follow:

	From earth.	From moon.		Eng. miles.
Mr. *Beacham*	218985	5688	Mr. *Mafon* 228302	5779
Mr. *Grimmet*	204395	7669	Mr. *Grant* 1090685659 and	
Mr. *Bulman*	202143	4166	27414940 Paris feet.	
Mr. *Hawkfworth*	231059	4955		

VII. Ques-

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* VI. QUESTION 148.

The above anfwers to this queftion are all wrong. For, the gravitation towards any body being as its quantity of matter directly and fquare of its diftance inverfly; if e to m denote the proportion of the quantity of matter in the earth to that in the moon, d the diftance of their centers, and x and z the refpective diftances, from their centers, of a body placed between them; then the gravitation towards the earth will be as $\frac{e}{x^2}$, and towards the moon as $\frac{m}{z^2}$: that the body be at reft between them then, or gravitate equally towards them, we muft make $\frac{e}{x^2} = \frac{m}{z^2}$, and hence $\sqrt{e} : \sqrt{m}$ $:: x : z$; that is, the diftances from them muft be as the roots of the maffes, which in the prefent cafe are nearly as $6\frac{1}{4}$ to 1.

Hence $\sqrt{e} + \sqrt{m} : d \ (= x + z) :: \begin{cases} \sqrt{e} : \dfrac{d\sqrt{e}}{\sqrt{e} + \sqrt{m}} = x, \\ \sqrt{m} : \dfrac{d\sqrt{m}}{\sqrt{e} + \sqrt{m}} = z. \end{cases}$

G g 3

❊ VII. QUESTION 149 *answer'd by Capt.* Wm. Scarth.

The latitude 26° 33' N. the hour 4 h. 13' 48″.

❧ VIII. QUESTION 150 *answer'd by Mr.* Geo. Anderson.

Put $AD = b$, $BD = d$, the latus rectum $= l$, and $x = bE$?
Per conics, $l : d + x ::$

$$d - x : \frac{dd - xx}{l} = bS,$$

By 35 Eucl. 1, $\dfrac{2ddx - 2x^3}{l}$

= area of the parallel.
   This in fluxions,

$$\frac{2dd\dot{x} - 6x^2\dot{x}}{l} = 0,$$

$dd = 3x\dot{x},$

Hence $x = d\sqrt{\frac{1}{3}} = 20.7846$, and $\dfrac{2ddx - 2x^3}{l} = 1108.512,$

&c. square chains = 110 a. 3 r. 16 p.

IX. QUES-

Here are given $Z\odot$ the co-altitude $= 57°$ (see the spherical tri-angle in page 227) $P\odot$ the co-declination $= 66° 31'$, and $ZP =$ the angle P.

Put $a = $ s. altitude $=$ cof. $Z\odot$,
   $d = $ s. declination $=$ cof. $P\odot$,
   $e = $ its cof. $= $ s. $P\odot$,
and $z = $ cof. PZ or $\angle P$.

Then, per spherics $\dfrac{a - dz}{e\sqrt{1 - z^2}} = z$;

Hence $eez^4 - cczz + ddzz - 2adz = - aa$; the root of which equation will answer the question.

✝ VIII. QUESTION 150.

If to the point b there be drawn a tangent meeting the abscissa and ordinate, produced, in P and $\mathcal{Q}$: Then, in all curves that are concave towards their axes, it is $\mathcal{Q}S = SD$, and therefore $DE = EP$ by similar triangles ; but, by the nature of the parabola, AE is $= \frac{1}{2}EP$; therefore $AE = \frac{1}{2}ED$ or $= \frac{1}{3}AD$; and consequently the height of the parallelogram $ED = \frac{2}{3}AD$. Also, since the ordi-nates of a parabola are as the square roots of their abscissas, and the abscissas being as 3 to 1, therefore the ordinates are as $\sqrt{3}$ to 1.
   So that $AD : AE :: 3 : 1,$
      and $BD : bE :: \sqrt{3} : 1.$
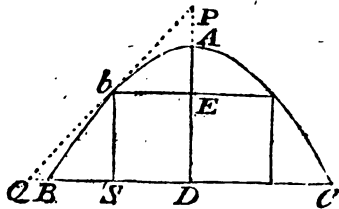
* IX. QUESTION 151 *anfwer'd.*

$$a = 85\text{·}379 \atop e = 79\text{·}899 \} \text{ their ages.}$$

The PRIZE QUESTION *anfwer'd.*

This queftion may admit of fome differences in the anfwer as the proportions vary in authors. I fhall therefore firft give you the propofer Mr. *Tho. Pointin's* anfwer.

The diftance of the earth and ☉ 80015040 miles.

From the center of ☽ to ☽　—　236350

From center ☉ to ☽ furface — 80251390

The weight of a body at the ☉ and ☽ as 1 to ·516; the force of the ☽ at ☽ ·516 — ·000284 : = ·515716 × 22650 = 11680·96 the weight at the ☽ ; by which the prime coft is 2 *l.* per hundred: for ·515716 × 100 × 22650 = 1168096·74) 2336193·48 (2. Let 2 a = *A*'s cafh, 4 a a = *B*'s, and 16 a⁴ + 8 a³ + a a = *C*'s ftock. Therefore 16 a⁴ + 8 a³ + 5 a a + a = fum. *A* = 6 price 12 lib. *B* 150, *C* 2250, and total ftock = 22650. The total gain 2290893, of which *A*'s gain = 606·8592 lib. *B*'s = 14564·6208, *C*'s = 2275722: the weight at the earth and Jupiter as 1 to 2·0108. So the weight will be 4554462 = 2033 tun 4 cwt. 94 lb. Mr. *Grimmet,* Mr. *Sidebottom,* Mr. *Bullman,* Mr. *Fearnfide,* Mr. *Pilgrim,* and fome others, make the weight at the moon 567 tuns, at Jupiter 2210 tuns. Mr. *Richards,* Mr. *Fairchild,* Mr.

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* IX QUESTION 151.

Of the two given equations $\begin{Bmatrix} a^3 e + a^2 e^3 = b \\ a^3 e^2 + a e^3 = c \end{Bmatrix}$, the latter being multiplied by *a,* and the former taken from the product, there remains $e^2 a^4 - e a^3 = c a - b$; hence $e = \dfrac{a \pm \sqrt{a^2 + 4 a c - 4 b}}{2 a^2}$: this being fubftituted in one of the original equations, there will refult an equation with only one letter in it, and which from it may be found.

Otherwife.

Take two near values of *a* and *e,* as 85 and 80, and call the differences *x* and *z*; then *a* = 85 + *x,* and *e* = 80 — *z*: fubftitute thefe in the two original equations, negleſting all the terms which rife to above two dimenfions, and there will refult two quadratic equations, from which *x* and *z* may be found.

Mr. *Hale*, Mr. *Lowe*, Mr. *Mason*, Mr. *Grant*, and fome others, 386 tun at ☽, and 15071 at Jupiter ; feveral of whom have wrought this queftion very curioufly, and in an algebraic method, but my room will not permit inferting them.

The prize of 10 diaries fell to the lot of Mr. *J. Pilgrim.*

Of the Eclipses in 1731.

To the inhabitants of this terraqueous globe this year will happen four eclipfes : Twice will the moon's opake body interpofe between the fun and us, and hinder part of his rays falling on the earth: And twice will the earth come between and hinder the fun's giving the moon her borrow'd light.

1. Moon eclipfed on Wednefday the 9th of june, at 3 quarters paft 1 in the morning, about 2 digits north.

Computed by	Begin h. m	Midd.	End	Dur.	Dig.
By Aftronom. Carol. Coventry	0 59	1 43	11 27	1 27	2 0
Mr. Chattock, London. —	1 1	1 54	2 46	1 44	2 44
Mr. Leadbetter, London —	1' 12	1 54	2 37	1 25	1 52
Mr. Turner — — —	0 59	1 45	2 31	1 32	2 2
Mr. Pilgrim — — —	1 4	1 49	2 35	1 31	1 59
Mr. Wm. Brown, Bridgenorth	0 55	1 39	2 22	1 27	2 0
Mr. J. Bulman, Lewifham in Kent	1 5	1 49	2 33	1 28	2 2
Mr. J. Fearnfide — — —	0 34	1 19	2 4	1 30	2 4
Mr. Oats, Falmouth — —	0 36	1 20	2 4	1 28	2 9
Mr. J. Newton, Melton Moberry	1 3	1 50	2 37	1 33	2 15

2. Sun eclipfed the 23d of june, at 1 min. paft 6 in the morning, but invifible, becaufe the moon having fouth latitude, her parallax depreffes her too much in our northern latitude.

3. Moon eclipfed the 2d of December, at 36 min. paft 11 in the morning, and confequently invifible to us.

4. Sun eclipfed the 17th of December, at 57 min. paft 12 at night, and therefore invifible to us.

New Questions.

I. QUESTION 151, by Mr. Tho. Williams.

Far in the weſt, I know not where,
But ſomewhere on this earthly ſphere,
A lofty pillar ſtands erected,
From the top of which a ball projected,
With a direction thirty-one
Degrees above the horizon,
Did, in nine ſeconds ten thirds ſpace,
Fall juſt two thouſand feet from its baſe.
    Artiſts, this pillar's height explain
    Above the horizontal plain.

II. QUESTION 152, by Mr. Geo. Anderſon.

Mr. Euclid Speidell, in his Geometrical Extractions, p. 59, ſays, If upon C, one end of the baſe CA, of the triangle ABC, you raiſe a perpendicular CD, equal to the perpendicular BP, let fall from B to CA, and join DA; that the right line CE biſecting the angle ACD, being produced, ſhall cut DA in ſuch a point F through which, if the right line GH be drawn parallel to the baſe CA, the part GH intercepted between the two ſides BC and BA, ſhall be the ſide of the ſquare made in the aforeſaid triangle.

Quere, The geometrical demonſtration?

III. QUESTION 154, by Mr. John Turner.

To Newton's genius, and immortal name,
And thoſe whoſe works in the records of fame
Like his will ever ſtand, what praiſe we owe;
Since 'tis from their diſcoveries we know
The various changes of the wand'ring moon,
And whence proceed th' eclipſes of the ſun;
What force the planets in their orbs retain,
Which move ſo ſwiftly thro' th' etherial plain;
What makes the ſea retreat, and what advance,
Varieties too regular for chance;
How vapours hanging on the lofty hills,
In breezes ſigh, or weep in warbling rills;
Whence infant winds their tender pinions try,
And tornado's bluſter in the ſky,
With ſome rais'd higher firſt in ſecret ſtreams,
Owe the reflected points of bounding beams;

Others,

Others, whofe parts a flight contexture fhow,
Sink hov'ring thro' the air in fleecy fnow;
And others laid in trains, that kindled fly,
In harmlefs fire by night, about the fky.
May we their bright examples emulate,
And mathematic knowledge propagate;
To anfwer which intent, ye fons of art,
Refolve the queftions which I here impart.

Let a ftone be whirl'd round in a fling, whofe length is equal to 33 inches, performing each revolution in the time of two-thirds of one fecond. Required the ratio of the centrifugal force to the weight of the ftone? That is, the ratio of the tenfion of the ftring whirled round in this manner, to the tenfion arifing from the force of the fame weight hanging freely, and without motion?

IV. QUESTION 155, *by the fame.*

Suppofe the earth's radius $=$ 6982000 yards, and that there is a mountain upon its fuperficies of fuch an height, that a clock when on the earth's furface, fhall point out equal time; but when carried to the top of the mountain, fhall be fo retarded as to err 2 minutes every day. 'Tis required to give that mountain's elevation.

V. QUESTION 156, *by* Mr. William Grimell.

Required the greateft parallelogram that can be infcribed in an ellipfis, whofe tranfverfe is 10, and conjugate 8: And fuppofing the ellipfis to revolve upon its tranfverfe axis, Required alfo the greateft cylinder that can be infcribed in the fpheroid that's generated by the revolving ellipfis? And to fhew the analytical inveftigation of the fame?

VI. QUESTION 157, *by* Mr. Chrift. Hale.

Unto a pleafant bower I took my way,
One evening late, it was the ninth of May;
Viewing the heav'ns, the works of mighty Jove,
Each glitt'ring ftar, in order as they move:
When one amongft the reft I did efpy;
Its rays of light came pointing to my eye.
Its name and latitude I fain would know;
From what is given here below.

The latitude of the place 29° 22'. The altitude is equal to the hour from noon, and equal to the azimuth.

VII. QUES-

VII. QUESTION 158 *by Mr.* John Fearnſide.

A garden lies on Ebor's fertile plains,
Where with magnificence fair Flora reigns:
She decks the flowers with moſt auſpicious hue,
The roſe vermilion, violet with blue.
Three lofty walls ſurround the beauteous place,
A curious ſtatue each of which does grace:
Erect they ſtand, and view th' adjacent plain,
Admir'd and ſeen by every neighb'ring ſwain.
Bacchus on this, on that Apollo ſtands;
Hermes (the meſſenger of Jove's commands)
Upon the third is plac'd, whoſe length, in feet,
Is known three hundred ſixty-three compleat.
With artful fancy, walks are form'd therein,
And various windings beautify the ſcene.
Three walks from the three effigies are made,
Where ſtately cedars yield a pleaſant ſhade;
The zephyrs revel in the ſportive boughs,
And kindly Sol's meridian heat ſubdues.
The walk from Hermes was to Bacchus known,
In feet and parts, as in the margin's ſhewn: (216·4074
And from Apollo to the other two
Is alſo given, as may be ſeen below.
Obſerve the walk between the unknown walls
At angles right, to one exactly falls,   (* 55°
Which wall ſubtends an angle given, * from whence
The garden's area, and the walks true lengths,
Ladies, to whom our annual praiſe is due,
Vouchſafe to tell? For nothing's hid from you.

From Apollo to $\begin{cases} \text{Bacchus } 192\cdot1306 \text{ feet,} \\ \text{Hermes } 209\cdot694. \end{cases}$

VIII. QUESTION 159, *by the ſame.*

What time of the day is the hotteſt at York on the 8th of June, ſuppoſing it to be as the ſine of the ſun's altitude, and the time of his continuance above the horizon?

IX. QUESTION 160, *by Mr.* Chr. Maſon.

In verdant meads, where I laſt ſpring ſurvey'd,
The flowing ſtreams did o'er the banks invade,
And forc'd me thence new methods to contrive:
So cowards fly, when ſeeming dangers drive.

I view'd

I view'd fome marks where on dry ground I ftood,
And then defpis'd the proud infulting flood.
From north to fouth I'd chains juft twenty-three,
Then weft two marks I in one line did fee.
Unto the firft I could no meafure take:
But 'tween the two I 40 chains did make.
Then to my northern ftation I apply'd,
Where the two weftern marks I plain defcry'd:
Thrice ten degrees the angle made from thence,
By which you now may find this confequence:
And in your next the diftances define,
From thofe two marks to th' ends of the firft line.

X. QUESTION 161, *by Mr.* Tho. Pointis.

In th' Atlantic ocean an ifland is found,
Neither oblong nor fquare, but perfectly round;
In the center of which a tower's erected,
From whence with much eafe their foes are detected:
For if Neptune but fmile, and the fky be ferene,
Four leagues * from the fhore is the horizon feen,
We being at anchor, o'er the top o'th' maft, ⎫
From the top o'th' tower a line being paft,   ⎬
Did bound the utmoft ftretch of fight at laft. ⎭
From thence we fet fail, and I'll tell you in fhort,
The diftance † we ran, to arrive at our port:
And alfo our courfe ‡ as corrected at noon,
Perform'd with great care by the height of the fun:
Which, to my furprize, neither higher nor lower,
Was cut in two halves by the fore-mention'd tower.
The height of our maft from the water's here fhown,
And whatever elfe is moft fit to be known §;
Which being fuppos'd, what I want to be found,
Is the tower's juft height, and land's compafs round.
Befides, when you're got in this figuring ftrain,
Let's know the fquare miles the whole doth contain.

* Note 69½ *miles to a degree, three of which are a league.*
† *Our diftance* ⅔ *of a degree.*
‡ *Our courfe N. by E.* 2° 45′ *E. or* 14° *from N. to E.*
§ *The height of the maft from the water* 45 *feet. Lat.* 64° 20′ *N. of the tower* 63° 56′. *The fhip's diftance from the fhore is* 1·263244 *leagues.*

XI. QUESTION 162, *by Mr.* C. Mafon.

It is required to find two fuch numbers, viz. *A* and *B*,
that the fum of the aliquot parts in *A* may be equal to ⅔ of
B, and the fum of the aliquot parts in *B* equal to ¼ of *A*.

The

The PRIZE QUESTION, *by Mr.* Pointin.

From noify courts, and from the jangling bar,
Where lawyers tongues proclaim litigious war,
My friend withdraws, to his paternal feat;
A golden mean betwixt too fmall, too great:
Where nature's wants ftill meet a full fupply,
With ample room for chriftian charity:
For great eftates but fofter up and feed
Thofe vices which their own exceffes breed.
    Here Strephon liv'd in plenty, free from cares,
And bleft contentment crown the circling years:
Vice here no favour found; 'twas virtue's court,
Where good and wife did ev'ry day refort.
A foe to ignorance, a friend to truth,
A prop to age, a ftar to wand'ring youth:
To th' fatherlefs, a gracious father was,
And ne'er forfook the mournful widow's caufe.
A friend to all; for all by him were fed,
The rich with wifdom, and the poor with bread.
Heav'n markt the man, from peaceful realms above,
Saw all his acts fpring from the fource of love,
To that great God, from whofe refulgent throne
Whate'er of good we have, is fhower'd down,
A faithful fteward of his ftock in truft,
And to reward him heaven thought it juft,
To all the good he had beftow'd before,
To add yet one, one precious bleffing more;
A bleffing, which to mortals here below
Is feldom fent, and none but fav'rites know,
A virtuous wife ! To whofe capacious mind
Both wit and beauty friendly nature join'd:
And as their years, fo did their loves increafe;
They liv'd contented, and they dy'd in peace.
Full well they knew, death but remov'd their feat,
Did not extinguifh life, but change its ftate;
Where is difplay'd (O ravifhing furprize !)
Rich fcenes of blifs, and glory in the fkies:
Two fons, their virtue fhare, which at one birth
Their pious mother with fmall pain brought forth.
His lands he gave, by good advice in law,
To both fo fure, that it admits no flaw.
The cafh and goods your judgment muft decide;
For fo by will it's plainly fpecify'd.
By what below is in few words declar'd,
The way you'll find by which it muft be fhar'd.

Call the eldeft *b*, the youngeft *c*: Then let $b + c = a$,
then $c + \dfrac{a}{5} = b$ per father's will: *D* hath a yearly income
or annuity that will fall to him feven years hence, and
thence to continue feven years; which fold at 6 per cent. $=$
$\sqrt{ab}$, and the rent $= \sqrt[3]{ca}$. Quere *a*?

1732.

Queftions anfwered.

I. QUESTION 151 *anfwer'd by* Mr. Rob. Fearnfide.

IN the fame time the ball defcribes
B E, another body let fall from
E wou'd fall the fpace *E F*, and
confequently in 9″ 10‴ time, when
the ball is at *H*, an heavy body will
defcribe *C H* = 1351·4 feet. Then
as cofine 31° : *B D* = 2000 feet ::
fine 31° : *C D* = 1201·7 feet ; con-
fequently the pillar's height = *C H*
— *C D* = 149·72 feet = *A B*.
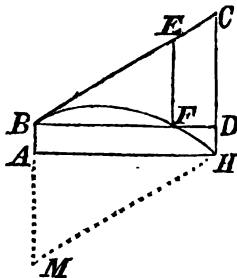
The fame anfwer'd by Mr. Wm. Grimmett.

Let *B A* reprefent the pillar, *A H* the diftance the ball
falls from the bafe of the pillar equal to 2000 feet.   Let *C H*
be perpendicular to *A H* ; *B C* the line in which the projectile
is directed, in which it would move equal fpaces in equal
times, were it not deflected downwards by the force of gra-
vity.   'Tis known all projectiles will (rejecting the refiftance
of the medium) defcribe parabolas : therefore *B C* is the
tangent of that parabola, *B D* is parallel to *A H* the ho-
rizon : draw *M H* parallel and equal to *B C* : confequently
M H is an ordinate to the diameter *B M*. Then in the right-
angled triangle *B D C* there is fufficient given to find the
fides. And fince the velocities of all projectiles in the feveral
points

points of the curve, are as the lengths of the tangents to the parabola in thofe points, intercepted between any two diameters; therefore $BC = 2333.33$ divided by $9\frac{1}{6}$ ($=$ number of feconds the ball was in motion) gives 254.54 the velocity in a fecond ; and the fquare of the velocity divided by $16\frac{1}{12}$ feet, the fpace a body defcribes in a fecond by gravity, gives the parameter to the diameter $B A$. That is (per conics) the rectangle under the intercepted part of the diameter taken from its origin B towards A, and the parameter, is $=$ the fquare of its correfpondent femiordinate : whence the parameter is $= 4028.43$; and the fquare of MH divided by the parameter, gives $BM = 1351.5$. But $BM - AM = BA = 149.5$ the height of the pillar.

* II. QUESTION 152 anfwer'd.

Produce HG to L, and draw Fm and GK parallel to PB.

$$(1)\ BP : BN :: CP : GN$$
$$(2)\ BP : BN :: PA : NH$$
per figure.

Per 11.5 Euc. $(3)\ CP : GN :: PA : NH$.
Per altern. $(4)\ CP : PA :: GN : NH$.
Per comp. $(5)\ CA : PA :: GH : NH$.
Per altern. $(6)\ CA : GH :: PA : NH$.
Per fteps 2.6. $(7)\ BP : BN :: CA : GH$.
But the $\angle MGF$ per hypothefis is $\frac{1}{2}$ a right angle, and CMF is a right angle, and confequently CEM is $\frac{1}{2}$ a right angle, and therefore CM or $LF = FM = GK$. Moreover $DC = BP$ per hypothefis, and $DL = BN$ per conftruction. Therefore
Per. ftep 7. $(8)\ DC : DL :: CA : GH$.
But per fig. $(9)\ DC : DL :: CA : LF$.
Then per $\}$ $(10)\ CA : GH :: CA : LF$.
11 E. 5. $\}$
Therefore $GH = LF = GK$.   Q. E. D.   Anfwer'd

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* II. QUESTION 152.

This conftruction may be otherwife demonftrated thus :

As DC or $BP : CA :: DF : FA$ (Eucl. VI. 3) :: $DL : LC$ or GK (Eucl. VI. 2), but, $BP : CA :: BN$ or $DL : GH$; $\therefore\ GK = GH$.

Why the propofer of the queftion calls *Speidell* by the name of *Euclid*, I know not. His name was *John*, as appears by the book, which was publifhed in the year 1617.

Anſwer'd by Mr. Will. Grimmett.

The geometrical demonſtration of this problem may be eaſily ſeen from the propoſer's own ſcheme, without any previous conſtruction, (viz.) Since there cannot be but one ſquare inſcribed in that poſition, and that *KC* is equal to *KF* each ſubtending an angle of 45° (per prob.) ; therefore if we prove that *KF* is = *GH* univerſally, it is demonſtrated ; for *KC* is equal to *GH* (which is ſuppoſed to be a ſide of a ſquare.)

Demonſtration.

From 37 Euc. 1, the triangles *DCB* and *DAB* are equal; and if an infinite number of right lines as *KH* be drawn parallel to the common baſe *DB*, the parts of thoſe lines which are intercepted by the reſpective ſides of the triangles, will alſo be equal, that is *KG* = *FH* ; which is Cavalerius's method of proving the triangles to be equal (which is the method of indiviſibles ;) therefore if to both be added or ſubtracted (as the caſe requires) *GF, KF* = *GH*.   *Q. E. D.*

III. QUESTION 154 *anſwered by the propoſer.*

As 113 : 355 :: 66 : 207·35 inches, the arch deſcribed in $\frac{2}{1}$ of 1″; and 207·35 ſquared and divided by 66, the double length of the ſling, is = 651·03 the centrifugal force. But the deſcent of a heavy body in $\frac{2}{1}$ of 1″ is = 86·2o8 inches: whence the centrifugal force is to the force of gravity as 651·4 to 85·7 or as 7·6 to 1.

The ſame anſwer'd by Mr. John Ommanney.

The ſtone, if let fall out of the ſling when at reſt, by the force of gravity would deſcend 85$\frac{1}{4}$ inches ; which call *b*. Now let *F* be the force of the ſtone or tenſion of the ſtring when at reſt; and *E* that when in motion. The lengths gone over are always proportional to the force impreſs'd. Therefore $F : E :: b : \frac{Eb}{F}$ the ſpace deſcended through with the force *E* in the ſame time. Let *c* = the circumference of the ſling = 207·344, and *d* = diameter = 66 ; then, by Sir Iſaac Newton, $\frac{cc}{d} = \frac{Eb}{F}$. Whence *F : E :: db : cc*. That is as 5659·5 to 42991·9, or as 1 to 7·596.   *Q. E. I.*

* IV. QUESTION 155 *answer'd*.

The number of oscillations in each place being equal, will be as the time in one place to the time in the other, viz. as 1440 to 1442. Let $n =$ earth's radius, and $a =$ radius and the height of the mountain together; the force of gravity being inversly as the square of the distance from the center, we shall have $1442 n = 1440 a$, and $\frac{1442 n}{1440} = 6991698 = a$; from which subtracting the radius of the earth $= 6982000$, remains the mountain's height $= 9698$ yards $= 5\frac{1}{2}$ miles 18 yards.

Answer'd

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* IV. QUESTION 155.

Universally, the lengths of pendulums being directly as the force of gravity drawn into the squares of the times of vibration, and the pendulum being of the same length in both cases, we shall have $f t^2 = F T^2$, putting f and t for the force of gravity and time of vibration at the earth's surface, and F and T for the same at the top of the hill. But the force of gravity is inversly as the square of the distance from the earth's center; that is f is as $\frac{1}{r^2}$, and F as $\frac{1}{\overline{r+x}|^2}$, putting r for the earth's radius, and x for the height of the hill; then the above equation becomes $\frac{t^2}{r^2} = \frac{T^2}{\overline{r+x}|^2}$, or $\frac{t}{r} = \frac{T}{x+x}$. Again the time of a vibration being inversly as the number of vibrations in a given time, and the number of vibrations being as 1440 to 1438; the same equation will become $\frac{1}{1440 r} = \frac{1}{1438 \times \overline{r+x}}$: Hence $x = \frac{2 r}{1438} = \frac{r}{719} = 9710 \cdot 7$ yards $=$ the height of the mountain required.

Corollary.

Hence it appears in general, that if l be the time lost in the time t; then 24 hrs. $- l : l :: r : x$; or, because 24 hours $- l$ is nearly $= 24$ hrs. it will be nearly as 24 hrs $: l :: r : x$; that is, the whole time is to the time lost, as the radius of the earth to the height of the hill.

H h 3

Anfwer'd by Mr. Geo. Anderfon.

The length of a pendulum vibrating feconds on the mountain's top will be = 39˙09 inches; therefore by Huygen's proportions the fpace defcended in a fecond of time on the top of the mountain will be 192˙9009 inches; and the fpace defcended in a vibration of the clock is 193˙4437 inches: And the gravity being defin'd by the fpace pafs'd over in a fecond of time. From corol. 2 prop. 5 theor. Principia Philofophiæ; put r = earth's radius, x = mountain's height.

$$r^2 + 2xr + x^2 : r^2 :: 193˙44 : 192˙9.$$

And therefore x = ˙0014059r = 353375˙7768 inches or 9815˙99 yards or 5˙5773 miles.

V. QUESTION 156 *anfwer'd by Mr.* John Turner.

Let $SD = t = 5$; $BS = c = 4$; $St = a$; $Dt = t + a$; and $At = t - a$. Then we have

As $tt : cc :: tt - aa$

$: \dfrac{cctt - ttaa}{tt}$ = fquare of

tx. Ergo $tx = \sqrt{\dfrac{cctt - ccaa}{tt}}$

and $Cx = \sqrt{\dfrac{4cctt - 4ccaa}{tt}}$.

This multiplied by $vt = 2a$, makes the area of the rectangle $ymxC = 2a\sqrt{\dfrac{4cctt - 4ccaa}{tt}} = \sqrt{\dfrac{16ccttaa - 16cca^4}{tt}}$:

But this, by the queftion, muft be a maximum; therefore the fluxion of t which is $\dfrac{32ccttaa - 64cca^3a}{2\sqrt{16ccttaa - 16cca^4}} = 0$. From

hence $64ccaa = 32cctt$: And $a = t\sqrt{\frac{1}{2}} = 3˙535$: And $2a = vt$ is = 7˙070, and ym or $xC = 5˙657$. Again for the greateft cylinder, fuppofing it to revolve about the tranfverfe axis, we found above $cx = \sqrt{\dfrac{4cctt - 4ccaa}{tt}}$.

Ergo cx fquared is $= \dfrac{4cctt - 4ccaa}{tt}$; this multiplied by $vt = 2a$ muft, per queftion, be a maximum. The fluxion of $\dfrac{8cctta - 8cca^3}{tt}$ is $8cctta - 24ccaaa = 0$. Hence we have by divifion and tranfpofition $a = t\sqrt{\frac{1}{3}} = 2˙887$: And $vt = 2a = 5˙774$ the cylinder's altitude, and xc or my the diameter of the bafe = 6˙532.   Q.E.I.

The
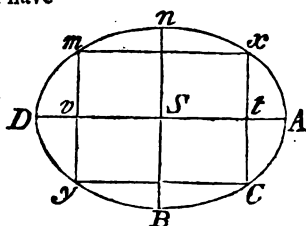
* The propofer's anfwer.

Put $d = AD$, $c = nB$, $x = Dv$, $y = yv$.

Then $2y$ and $d - 2x$ the fides of the parallelogram; the rectangle of which is $2yd - 4xy$, the fluxion of which, if a maximum, is $2d\dot{y} - 4x\dot{y} - 4x\dot{y} = 0$, $= d\dot{y} - 2x\dot{y} - 2x\dot{y} = 0$.

By the property of the ellipfe $dd : ce :: dx - xx : yy$.

Ergo $y = \sqrt{\dfrac{dccx - ccxx}{dd}}$.

In fluxions $\dot{y} = \dfrac{dc\dot{c}x - 2cc x\dot{x}}{2d\sqrt{dccx - ccxx}}$. Which fubftituted in

the

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* V QUESTION 156.

In the folution of queftion 74, at page 181, it is proved that $CE = CA\sqrt{\frac{1}{3}}$, [*fee the fig. to that folution*] and $EF = CD\sqrt{\frac{2}{3}}$; CE being half the height, and EF half the diameter of the cylinder, when CA is the femitranfverfe, and CD the femiconjugate axe.

Again, fuppofing CE and EF to be the halves of the length and breadth of the greateft infcribed parallelogram, by page 201 Simpfon's Geom. 2d edit. CE is $= \frac{1}{2}CT$, and $EF = \frac{1}{2}CK$; but, by the nature of the ellipfe, $CE : CA :: CA : CT$ or $2CE$; hence $CE = CA\sqrt{\frac{1}{2}}$. And in like manner $EF = CD\sqrt{\frac{1}{2}}$.

Corollary.

Hence, if t and c denote the whole tranfverfe and conjugate axes,

Then $t\sqrt{\frac{1}{2}}$ = length of the greateft rectangle,

$\quad\quad c\sqrt{\frac{1}{2}}$ = breadth of the fame,

$\quad\quad \frac{1}{2}ct$ = area of the fame.

And $t\sqrt{\frac{1}{3}}$ = length of the greateft cylinder,

$\quad\quad c\sqrt{\frac{2}{3}}$ = diameter of it,

$\quad\quad \dfrac{2c^2 t n}{3\sqrt{3}}$ = content of it, putting $n = .13539$ &c.

the former, we have $\dfrac{d c c \dot{x} - 2 c c x x}{\sqrt{d c c x - c c x x}} - 2 \dot{x} \sqrt{\dfrac{d c c x - c c x x}{d d}}$

$- \dot{x} \times \dfrac{d c c \dot{x} - 2 c c x x}{d \sqrt{d c c x - c c x x}} = 0.$ Which reduced, then $x x$

$- d x + d d = - \frac{1}{8} d d.$

Hence $x = \frac{1}{4} d - \dfrac{d}{\sqrt{8}} = 1\cdot4645 = D v$: from whence $m x$ will be found $= 7\cdot071$, and $m y = 5\cdot6568$: and the area of the greatest parallelogram $= 39\cdot999999.$ *Q.E.I.*

VI. QUESTION 157 *answer'd by Mr.* Geo. Anderson.

In contemplating on the solution of the 159th question, I hit upon the following lemma, which I find to be so useful in solving astronomical questions of that kind, that I believe there can no such question be proposed, but it will be found a useful instrument in solving it.

In the spherical triangle let P be the north pole, Z the zenith, $\odot$ the place of the sun: And

Put $\begin{cases} 1 = \text{radius,} \\ a = \text{tangent of } Z P, \\ s = \text{cosine of } Z P, \\ d = \text{right sine } \odot P, \\ e = \text{cosine of } \odot P, \\ g = \text{cosine of } \odot Z, \\ x = \text{cosine of } \odot P Z. \end{cases}$
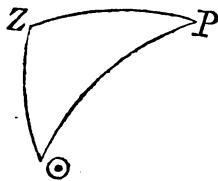
LEMMA.

$\overline{e + d a x} \times s = g.$

Corollary.

In question 157 there is given the latitude of the place, and the altitude equal to the hour from noon and to the azimuth, to find the latitude of the star (or declination with respect to the sun); therefore in the room of g in the lemma put $\sqrt{1 - x x}$ ($=$ sine of the hour) and there will be had $e + d a x \times s = \sqrt{1 - x x}$, from the equality of the hour and altitude. And now to answer the other parts of the question, because the azimuth is equal to the hour, therefore the same x still represents the cosine of the angle $\odot Z P$, and the theorem must be so transposed that $\odot Z P$ may be the angle contain'd: wherefore since $Z P$ is one of the containing sides of the angle $\odot Z P$, as well as of the angle $\odot P Z$,

therefore

therefore a and s may ſtill retain their former office, but for d muſt be wrote $\sqrt{1 - gg}$, and for e put g, and for g write e, and for e put x, and then the lemma will ſtand thus, $x + ax\sqrt{1 - gg} \times s = e$. But becauſe $\sqrt{1 - gg} = x$, the theorem will be $sx + saxx = e$; therefore from the two equations $e + ax\sqrt{1 - ee} \times s = \sqrt{1 - xx}$, and $x + saxx = e$, exterminate e you'll have this equation $s^8 a^8 x^{12} + 4s^8 a^7 x^{11} + 8s^8 a^6 x^{10} + 12s^8 a^5 x^9 \left.{\begin{matrix} - \\ + \end{matrix}}{\begin{matrix} 2s^4 a^4 \\ 14s^8 a^4 \end{matrix}}\right\} x^8$

$$\left.{\begin{matrix} - 4s^4 a^3 \\ + 12s^8 a^8 \end{matrix}}\right\} x^7 \left.{\begin{matrix} + 2s^4 a^4 \\ - 4s^6 a^4 \\ + 8s^8 a^2 \end{matrix}}\right\} x^6 \left.{\begin{matrix} + 4s^4 a^3 \\ + 4s^4 a \\ + 4s^8 a \\ - 8s^6 a^3 \end{matrix}}\right\} x^5 \left.{\begin{matrix} + 2s^4 \\ - 4s^6 a^2 \\ + s^8 \\ + 1 \end{matrix}}\right\} x^4$$

$- 4s^4 ax^3 \left.{\begin{matrix} - 2s^4 \\ - 2 \end{matrix}}\right\} x^2 + 1 = 0$. Which in numbers reduced will give the coſine of the hour.

<div align="center">The propoſer's anſwer.</div>

Let $\sqrt{1 - aa} =$ ſine of $Z\odot$ or $P\odot$, $b =$ ſine of ZP comp. lat. $60° 38'$, $n =$ ſine lat. $29° 22'$, $a =$ ſine of the altitude.

As $\sqrt{1 - aa} : a :: b : \dfrac{ab}{\sqrt{1 - aa}} =$ ſine $\angle Z\odot P$ and

$1 - \dfrac{b^2 a^2}{1 - aa} =$ the ſquare of its coſine; $1 - aa : 1 :: 1 - n$

$: \dfrac{1 - n}{1 - aa} =$ verſed ſine $\angle Z\odot P$, and $\dfrac{n - aa}{1 - aa} =$ coſine $\angle Z\odot P$. Hence $\dfrac{nn - 2nda + a^4}{1 - aa} = 1 - aa - a^2 b^2$. Reduced we have $a = ·7493411 =$ ſine of $48° 33'' =$ to the altitude and latitude of Perſeus's right ſide.

VII. QUES-

<div align="center">* VI. QUESTION 157.</div>

In this queſtion, is given ZP, the $\angle Z = \angle P =$ comp. $\odot Z$ or $\odot P$, the triangle being iſoſceles. Then

Suppoſing a perpendicular demitted from $\odot$ upon and biſecting ZP, and thereby dividing $\odot ZP$ into two equal right-angled triangles; put $a =$ the tangent of the baſe of each or of half PZ the given colatitude, and $x =$ ſine of the hypothenuſe $\odot P$ or $\odot Z =$ coſ. $\angle P$ or Z; then, by right angled triangles, (radius $=$) $1 : x$

$:: \dfrac{x}{\sqrt{1 - x^2}}$ (= tang. $\angle P$ or Z) $: \dfrac{x^2}{\sqrt{1 - x^2}} = a$; hence x^4

$= a^2 - a^2 x^2$, and $x = \sqrt{a\sqrt{\frac{1}{4}a^2 + 1} - \frac{1}{4}a^2} =$ the coſine of the declination.

* VII. QUESTION 158 *anfwer'd by Mr.* J. Fearnfide.

Let $DC = m$, $AB = b$, $AH = c$, $HB = a$, fin. $\angle D$ $= s$, its cof. $= l$, fin. $\angle CAH = r$, fin. $HBA = u$, its cof. $= t$, and $BF = x$.

Then will fin. $\angle F = \dfrac{b}{x}$, and its cof. $=$

$\sqrt{\dfrac{xx - bb}{xx}}$; fin. $C = \dfrac{bl}{x} + s\sqrt{\dfrac{xx - bb}{xx}}$;

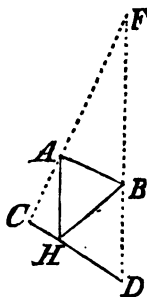$HC = \dfrac{cr}{\dfrac{bl}{x} + s\sqrt{\dfrac{xx - bb}{xx}}}$; fin. $HBD =$

$\dfrac{ub}{x} + t\sqrt{\dfrac{xx - bb}{xx}}$; and $HD =$

$\dfrac{uba}{sx} + \dfrac{ta}{s}\sqrt{\dfrac{xx - bb}{xx}}$. Whence this

equation $\dfrac{cr}{\dfrac{bl}{x} + s\sqrt{\dfrac{xx - bb}{xx}}} + \dfrac{aub}{sx} + \dfrac{ta}{s}\sqrt{\dfrac{xx - bb}{xx}} = m$.

Which reduced gives $x = 233\cdot10474$. Therefore $DF = 412\cdot5$, $CF = 427\cdot4$, and the area 1 ac. 1 r. 20 p.

This queftion being unlimited, as not determined on which wall Bacchus or Apollo ftands, will admit of another anfwer.

VIII. QUES-

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* VII. QUESTION 158.

In this queftion it is required, about a given triangle to circum-fcribe another triangle fuch, that one of its angles, and one of the fides about that angle, fhall be each of a given magnitude; and the fide oppofite to the given angle perpendicular to a fide of the given infcribed triangle.

And hence if upon the given line BH be defcribed the fegment of a circle capable of containing the given angle D, the problem is reduced to this: To apply a line CD of a given length between the circumference of that circle and the line CF given in pofition, and fo as to pafs through the given point H.

* VIII. QUESTION 159 *anfwer'd by* Mr. Anderfon.

Given the latitude, the fun's declination, and the fun's heat, as the fine of his altitude and continuance above the horizon (viz. as their product) for fo I take it, and was fo inform'd by E. Stone, who propos'd the fame queftion in his preface to d' Hofpital's fluxions.

Lemma

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* VIII. QUESTION 159.

Put s and c = the fine and cofine of PZ, d and e = fine and cofine of $P\odot$, m = the femi-diurnal arc, x = the hour arc or $\angle P$, y = its fine, and z = fine of the altitude or cofine of $Z\odot$.

Then $mz + xz$ = a maximum, per queftion,

or $m\dot{z} + x\dot{z} + \dot{x}z = 0$.

But $z = ce + ds\sqrt{1 - y^2}$, or $\dot{z} = \dfrac{-ds\,y\dot{y}}{\sqrt{1 - y^2}}$; and

$\dot{x} = \dfrac{\dot{y}}{\sqrt{1 - y^2}}$.

Wherefore $\dfrac{-ds\,my\dot{y}}{\sqrt{1 - y^2}} - \dfrac{ds\,xy\dot{y}}{\sqrt{1 - y^2}} + ds\dot{y} + \dfrac{ce\dot{y}}{\sqrt{1 - y^2}} = 0$,

or $ce - ds\,my - ds\,xy + ds\sqrt{1 - y^2} = 0$,

and hence $x = \dfrac{ce - ds\,my + ds\sqrt{1 - y^2}}{ds\,y}$.

Now this equation may be refolved after feveral different manners. One method is to fubftitute in it the value of x in terms of y in an infinite feries, and this will be like the two original folutions : Or a finite approximate value of x in terms of y may be fubftituted for it, and then the refulting equation will be finite : Or fome method may be ufed for approximating to the values of x and y immediately from the equation as it ftands above, which will be eafieft and fooneft done ; and the beft method for that purpofe feems to be this; by a few trials find $y = \cdot 5$ nearly, which fubftituted in the above form, a near value of x will be found ; from a table of fines, to this value of x take the correfpondent value of y, which written in the above form again, there will be had a *nearer value of x*; and fo on as far as neceffary.

Lemma $\overline{e + dax} \times s =$ fine fun's altitude, as in queſtion
157. But $x + \frac{1}{6}x^3 + \frac{3}{40}x^5 + \frac{5}{112}x^7 + $ &c. is the arch
belonging to x, and $b - x - \frac{1}{6}x^3 - \frac{3}{40}x^5 - \frac{5}{112}x^7$ &c.
(putting $b = \frac{1}{4}$ of the circumference) is the complement of it,
and therefore the hour from noon: Put $r =$ the time (viz.
the length of the arch of the equinoctial) paſs'd over from
fun-riſing to noon; Now it is manifeſt the aforeſaid phæno-
menon will not happen before the ſun's arrival at the meri-
dian, therefore $r + b - x - \frac{1}{6}x^3 - \frac{3}{40}x^5 - \frac{5}{112}x^7 - $&c.
is the ſun's continuance above the horizon, and this multi-
plied by $se + sdax$ the ſine of the altitude, and thrown into
fluxions and reduced gives $2sdax + \frac{1}{2}sex^2 + \frac{2}{3}sdax^3 + \frac{3}{8}sex^4 + \frac{9}{20}sdax^5 + \frac{5}{16}sex^6 + \frac{5}{14}sdax^7 + $ &c. $=$
$sdar + sdab - se - m$. And therefore $x = \dfrac{m}{2sda} -$
$\dfrac{m^2}{2se \times \overline{2sda}^2} + \dfrac{3ees - 4da}{4da} \times \dfrac{m^3}{\overline{2sda}^3} - $ &c.

The propoſer's anſwer.

Let $m =$ the rectangle of the fine com. lat. and co-
declination, $p =$ fun's alt. at 6, $n =$ the length of the ſemi-
diurnal arch, and z the length of the arch from noon. The
coſine of the hour angle from noon is $= 1 - \dfrac{zz}{2} + \dfrac{z^4}{24} - \dfrac{z^6}{720}$
&c. and, putting $m + p = a$, the ſine of the fun's altitude
will be $= a - \dfrac{mzz}{2} + \dfrac{mz^4}{24} - \dfrac{mz^6}{720}$, &c. Which mul-
tiplied by $n + z$, and thrown into fluxions, &c. gives
$mnz + \dfrac{3m}{2}z^2 - \dfrac{mn}{6}z^3 - \dfrac{5m}{24}z^4 + $ &c. Revers'd z will
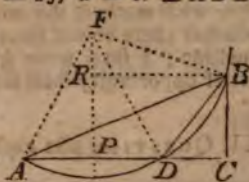be $= \cdot 5c614$ (the radius being 1) conſequently the hour is
1 h. 56' afternoon.

IX. QUESTION 160 *anfwer'd by the author Mr.* Mafon.

Let $AD = b = 40$, $BC = c = 23$, $d = s$. $\angle ABD = 30°$, $a = DC = ?$

Per 47 E. 1, $\sqrt{b^2 + 2ba + aa + cc}$
$= AB$; for which fubftitute y:

then $y : 1 :: c : \frac{c}{y} = s. \angle BAC$;

and $d : b :: \frac{c}{y} : \frac{bc}{dy} = DB$; per

47 E. 1, $\frac{bbcc}{ddyy} - cc = aa$. i.e. $bbcc - ccddyy = ddyyaa$:

for yy put its value. Then $a^4 + 2ba^3 + bbaa - 2bca$
$= \frac{bbcc}{dd} + c^4 - bbcc$: which reduced gives $a = 18\cdot3$,
$AB = 62\cdot672$, $DB = 29\cdot392$.

Anfwer'd by Mr. John Bulman.

On the given fegment $AD = 40$ chains (per 33 Eucl. 3) defcribe a fegment of a circle which fhall contain the given angle $ABD = 30°$. And from F the center thereof let fall the perpendicular FP upon AD; make $PR = 23$, and draw RB parallel to AD meeting the circle in B; and let fall the perpendicular BC. Then the lines FB, FD, FA will all be equal as being radius's of the fame circle.

The angle AFD is double the angle ABD (per 20 E. 2); therefore the triangle AFD is equilateral, and confequently equiangular, each fide being 40 chains, and each angle 60°. Then $FD^2 - PD^2 = FP^2$ (per 47 E. 1); whence $FP = 34\cdot641$, and $FP - BC = FR = 11\cdot641$. Again $FB^2 - FR^2 = RB^2$; whence $RB = 38\cdot2686$, and $RB - PD = DC = 18\cdot2686 =$ the diftance of the nearest mark from the end of the firft line: Hence BD may eafily be found $= 29\cdot3628$ chains, and $BA = 62\cdot6438$. *Q. E. I.*

X. QUESTION 161 *anfwer'd by the author.*

The longitude is $20' \; 23'' \; 2''' \; 24''''$; from which and two latitudes is found the tower's diftance $26' \; 12''$. The arch of diftance between the fhip and horizon is $7' \; 5'' \; 16''' \; 48'''' + 26' \; 12'' = 33' \; 17'' \; 16''' \; 48''''$. By which $326\cdot15264$ yards is the tower's height, and $56\cdot6202$ leagues the ifland's compafs, alfo the area $2193\cdot2553$ fquare miles.

Several have attempted the folution of this queftion; but differ widely from the author, viz. Mr. *Grimmett* and Mr. *Bulman* make the ifland's compafs 657 leagues; Mr. *Ommanney* 50 leagues; others 26 leagues : And not knowing after what method the author proceeded for his anfwer, or whether there be not fome miftake in the manufcript of this queftion ; I fhall wave giving thofe other methods till a better opportunity fhall fet this matter right.

XI. QUESTION 162 *anfwer'd by the propofer* Mr. Mafon.

$$A = 404 : B = 465.$$

Mr. Robert Fearnfide's *anfwer.*

Let $2y =$ fum of the aliquot parts in A; and $3z =$ fum of the aliquot parts in B : Then $3y$ will be $=$ fecond number B; and $4z = A$. Now $1 + 2 + 4 + z + 2z = 2y$; and $1 + 3 + y = 3z = 2y - 7$. Confequently the firft number A will be found to be 20, and $B = 33$.

For $1 + 2 + 4 + 5 + 10$ is $= \frac{2}{3}B$; and $1 + 3 + 11$ is $= \frac{3}{4}A$.

Mr. Grimmett's *anfwer.*

It is fuppofed that $\frac{3}{4}$ of A is an integer, becaufe the fum of the aliquot parts in B is $=$ to it; and likewife $\frac{2}{3}$ of B is an integer for the fame reafon; therefore the number A muft be a multiple of 4; and the number B a multiple of 3. Make therefore $A = 4a$; its aliquot parts are $2a, a, 4, 2, 1$ the fum of which is $3a + 7$. Put alfo $B = 3e$; the fum of the aliquot parts of which is $e + 4$; and per queftion $3a + 7 = 2e \ (= \frac{2}{3}B)$; alfo $e + 4 = 3a \ (= \frac{3}{4}A)$. Whence a is found $= 5$, and $e = 11$. Confequently $4a = 20 =$ the number A; and $3e = 33 = B$.

The Prize Queftion anfwered by Mr. Rob. Fearnfide.

Let $x^6 = A, y^6 = B, z^6 = C$; then $z^6 + \dfrac{x^6}{5} = x^6 - z^6$; confequently $y = z\sqrt[6]{\dfrac{10}{4}}$ and $x = y\sqrt[6]{\dfrac{10}{6}}$. Now by Ward's

Theorem,

Theorem, p. 271, we shall have (putting $r = \sqrt[3]{\frac{2}{3}}m = $ $1\cdot50363$, $n = 1\cdot06$) $\dfrac{n m^2 x^3 y^3 - m^2 x^3 y^3}{m = 1} = 22xx = $ rent

whence by substitution, &c. $x^2 = \dfrac{m-1}{n-1} \times \dfrac{r}{1 m^2} = 3\cdot5316.$

Then $x^6 = A = 44\cdot047579$, $B = 26\cdot423547$, and $C = 17\cdot61903.$*

The

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* The PRIZE QUESTION.

In this question, for determining the three quantities, x, y, z, there are given the two equations $x + y = z$, and $y + \dfrac{z}{s} = x$: And the third equation is to be made out from these following conditions, viz. that $\sqrt[3]{xz}$ is the present value of a yearly rent, which is expressed by $\sqrt[3]{yz}$, to continue for 7 years, but the first payment not to become due till the end of the 8th year; the interest of money being reckoned at 6 per cent.

From the two first equations we easily find $x = \dfrac{3z}{s}$, and $y = \dfrac{2z}{s}$; consequently the yearly rent becomes $\sqrt[3]{\dfrac{2z^2}{s}}$, and the present of it $\sqrt{\dfrac{3z^2}{s}}$ or $z\sqrt{\dfrac{3}{s}}$. But by any calculated table of reversions at 6 per cent. it appears that the present worth of one pound due 8 years hence is $\cdot6274$, the present value due 9 years hence $\cdot5919$, the same for 10 years $\cdot5584$, for 11 years $\cdot5268$, for 12 years $\cdot4970$, for 13 years $\cdot4688$, and for 14 years $\cdot4423$: the sum of these is $3\cdot7116$ which is the present value of 1 for those 7 years, and consequently $3\cdot7116 \sqrt[3]{\dfrac{2z^2}{s}} = $ the present value of $\sqrt[3]{\dfrac{2z^5}{s}}$ annuity for the same time, and which must be equal to $z\sqrt{\dfrac{3}{s}}$, that is $3\cdot7116 \sqrt[3]{\dfrac{2z^2}{s}} = z\sqrt{\dfrac{3}{s}}$; hence then z is $= 3\cdot7116^3 \times \dfrac{2}{3}\sqrt{\dfrac{s}{3}}$ $= 3\cdot7116^3 \times \dfrac{2\sqrt{15}}{9} = 44\cdot042$. Consequently $x = \dfrac{3z}{s} = 26\cdot4252$, and $y = \dfrac{2z}{s} = 17\cdot6168.$

The same otherwise answered.

Let $\left\{\begin{array}{l}1\\2\\3\end{array}\right.$ | $a =$ the cash to be divided,
$b = B$'s part,
$c = C$'s part.

Then | 4 | $b - \dfrac{a}{5} = c$ per question

$2 + 4$ | 5 | $2b - \dfrac{a}{5} = a.$

$5 \times \overline{5+a}$ | 6 | $10b = 6a.$

$6 \div \overline{6}$ | 7 | $\dfrac{10b}{6} = a.$

$7 \div \overline{5}$ | 8 | $\dfrac{10b}{30} = \dfrac{b}{3} = \dfrac{a}{5}.$

$2 - 8$ | 9 | $\dfrac{3b - b}{3} = \dfrac{2b}{3} = C$'s part.

$.7 \times 2$ | 10 | $\dfrac{10bb}{6} =$ the square of the purchase.

7×9 | 11 | $\dfrac{10bb}{9} =$ the cube of the yearly rent.

Subftit. | 13 | $m^2 = \dfrac{10}{6}.$

Then | 14 | $mmbb = \dfrac{10bb}{6}$

14 extr. | 15 | $mb =$ the purchase (which per Ward, p. 246 theo. 1)
Will be | 16 | $rtmb + mb =$ the value at the time of purchase,
which per 2d theor. Ward, p. 249.

Will be | 17 | $\dfrac{2rtmb + 2mb}{ttr - tr + 2t} = u \left\{\begin{array}{l}\text{put } 2tm = x; \text{ and } 2m = z;\\ \text{and } ttr - tr + 2t = d.\end{array}\right.$

Then | 18 | $\dfrac{xb + zb}{d} = u.$

18 cub. | 19 | $\dfrac{x^3 b^3 + 3xxzb^3 + 3xzzb^3 + z^3b^3}{d^3} = \dfrac{10bb}{9}$

$19 \times \& \div$ | 20 | $b = \dfrac{\frac{1}{9}ddd}{x^3 + 3xxz + 3xzz + z^3} = 101 \cdot 730562$

C's part $= 67 \cdot 820375$
Cash to be divided $= 169 \cdot 550937$
The annuity or income $= 22 \cdot 577929$

The prize of 10 diaries fell to Mr. Rob. Fearnside.

End of the First Volume.